

Atmosphere

9th ANNUAL CONGRESS

**May 28-30
1975**

**University of British Columbia
Vancouver**

**Canadian Meteorological Society
Société Météorologique du Canada**

ATMOSPHERE

Volume 13 = 9th Annual Congress Issue

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NINTH ANNUAL CONGRESS

CANADIAN METEOROLOGICAL SOCIETY

The Ninth Annual Congress and Annual Meeting of the Canadian Meteorological Society will be held at the University of British Columbia, Vancouver, B. C., in the period 28-30 May, 1975.

The theme session of the Congress is entitled "The Role of the Pacific Ocean in the Climate of North America". This session will occupy the morning of May 28 and is composed of invited speakers who will review the coupling of the Ocean and the Atmosphere, its importance in Global Climate Modelling, and the specific implications of the state of the Pacific Ocean on the Climate of North America.

The theme is particularly appropriate this year as the Society welcomes the participation of a group of Canadian oceanographers to the Congress. This participation includes collaboration in three joint meteorology/oceanography sessions (theme session and two air/sea interaction sessions), and a series of parallel, concurrent technical sessions. There are sixteen meteorological, and twelve oceanographical technical sessions. Programme Chairman for the Congress is Dr. T. R. Oke, Department of Geography, University of British Columbia.

The British Columbia Centre of the CMS is the host for the Congress. Chairman of the Local Arrangements Committee Dr. T. A. Black, Department of Soil Science; University of British Columbia.

SUMMARY OF SESSIONS

Wednesday, May 28

			Instructional Resource Centre	
0830 - 0850	Opening Welcome		Theatre Number 2	
0850 - 1200	Theme Session			2
1330 - 1500	1	Planetary Boundary Layer, Part I - Turbulence		2
1330 - 1500	2	Applied Meteorology		1
1330 - 1500	3*	Physical Oceanography, Part I - The Arctic		3
1530 - 1700	4	Planetary Boundary Layer, Part II - Mesoscale Structures		2
1530 - 1700	5	Cloud Physics		1
1530 - 1700	6*	Physical Oceanography, Part II - Water Movement		3
Evening		Annual General Meeting CMS, Ruth Blair Lounge, Gage Complex (followed by cash bar)		

Thursday, May 29

0830 - 1000	7	Dynamic Meteorology, Part I - Forecast Applications		2
0830 - 1020	8*	Physical Oceanography, Part III - Seiches and Internal Waves		1
0830 - 1000	9*	Chemical Oceanography		3

*Oceanographic Session

1030 - 1200	10	Air Pollution Meteorology, Part I - Macroscale	2
1050 - 1200	11*	Physical Oceanography, Part IV - Ocean Turbulence and Microstructure	1
1030 - 1200	12*	Interaction of Biological, Physical and Chemical Processes, Part I	3
1330 - 1500	13	Urban Meteorology	2
1330 - 1500	14**	Air-Sea Interaction, Part I	1
1330 - 1500	15*	Interaction of Biological, Physical and Chemical Processes, Part II	3
1530 - 1720	16	Climatic Change	2
1530 - 1700	17**	Air-Sea Interaction, Part II	1
1530 - 1700	18*	Interaction of Biological, Physical and Chemical Processes, Part III	3
Evening		Banquet and Awards Presentation (Speaker Dean David Bates, Faculty of Medicine, UBC)	

Friday, May 30

0830 - 1000	19	Air Pollution Meteorology, Part II - Urban and Regional	2
0830 - 1000	20	Dynamic Meteorology, Part II - General	1
0830 - 1000	21*	Estuarine Processes, Physical and Chemical, Part I	3
1030 - 1220	22	Forest and Agricultural Meteorology	2
1030 - 1200	23	Hail	1
1030 - 1200	24*	Estuarine Processes, Physical and Chemical, Part II	3
1330 - 1500	25	Remote Sensing	2
1330 - 1500	26	Dynamic Meteorology, Part III - Models	1
1420 - 1500	27*	Dynamics of Inshore and Inland Waters, Part I	3
1530 - 1700	28	Air Pollution Meteorology, Part III - Local Dispersion	2
1530 - 1700	29	GATE	1
1530 - 1700	30*	Dynamics of Inshore and Inland Waters, Part II	3

*Oceanographic Session

**Joint session

PROGRAM

Wednesday Morning, May 28, 1975

0830 - 0850

Opening Welcome: Dr. W. Gage, President
University of British Columbia

Dr. A. Robert, President
Canadian Meteorological Society

Dr. C. Mann, CMS Subcommittee
on Oceanography

THEME SESSION *The Role of the Pacific Ocean
in the Climate of North America*

Wed 0850 - 1200

Chairman: A. Robert

Location: IRC 2*

OCEAN/ATMOSPHERE COUPLING AND GLOBAL CLIMATE MODELLING
S. H. Schneider, National Center for Atmospheric Research, Boulder,
Colorado, U.S.A.

STRUCTURE AND CIRCULATIONS OF THE PACIFIC OCEAN
S. Tabata, Marine Sciences Branch, Department of the Environment,
Victoria, B. C.

Coffee (1040 - 1100)

CLIMATIC FLUCTUATIONS AS A CONSEQUENCE OF PACIFIC OCEAN/ATMOSPHERE
COUPLING

H. Flohn, Meteorologisches Institut, Universität Bonn, Bonn, W. Germany

Lunch (1200 - 1330)

Wednesday Afternoon, 28 May 1975

SESSION 1 *Planetary Boundary Layer, Part I
Turbulence*

Wed 1330 - 1500

Chairman: K. D. Hage

Location: IRC 2

THE APPROACH TO LOCALLY ISOTROPIC TURBULENCE
G. A. McBean, Atmospheric Environment Service, Downsview
J. A. Elliott, Bedford Institute of Oceanography, Dartmouth

STOCHASTIC CHARACTER OF STRAINING MOTION IN 2-D TURBULENCE
M. Shabbar, Atmospheric Environment Service, Downsview

*IRC - Instructional Resource Centre Theatre number.

GEOMETRIC SIMILARITY FOR THE TEMPERATURE FIELD IN THE UNSTABLE
ATMOSPHERIC SURFACE LAYER

D. S. Davison, Atmospheric Environment Service, Downsview

THE VARIABILITY OF TURBULENCE STATISTICS IN THE PBL OVER THE CANADIAN
PRAIRIES

D. Davidson, Atmospheric Environment Service, Downsview

M. Miyake, University of British Columbia

Coffee (1500 - 1530)

SESSION 2 Applied Meteorology Wed 1330 - 1500

Chairman: G. A. McKay Location: IRC 1

THE IMPORTANCE OF CLIMATE TO RECREATION - TOURISM FACILITY PLANNING

R. B. Crowe, Atmospheric Environment Service, Downsview

CLIMATIC SUITABILITY FOR OUTDOOR RECREATION AND TOURISM ON
THE CANADIAN PRAIRIES

J. M. Masterton, Atmospheric Environment Service, Downsview

EMPLOYING WEATHER DATA TO REDUCE FUNGICIDE USAGE ON CARROTS

T. J. Gillespie and W. J. Langenberg, University of Guelph

THE ENERGY BUDGET OF AN ARID AREA AS AN INDICATOR OF POTENTIAL
AGRICULTURAL WATER USE AND ITS ROLE IN CLIMATIC CHANGE

E. Vowinkel and S. Orvig, McGill University

Coffee (1500 - 1530)

SESSION 3 Physical Oceanography - Part I Wed 1330 - 1500
The Arctic

Chairman: P. H. LeBlond Location: IRC 3

PHYSICAL OCEANOGRAPHY OF THE SOUTH-EASTERN BEAUFORT SEA, 1974

B. R. de Lange Boom and R. H. Herlinveaux, Ocean and Aquatic Affairs
Pacific Region, Victoria

VOLUME AND HEAT TRANSPORT THROUGH NARES STRAIT AND SOME PROBLEMS
IN BAFFIN BAY

H. E. Sadler, Defence Research Establishment Ottawa

NEAR-SURFACE CURRENTS IN ROBESON CHANNEL

R. K. Chow, Defence Research Establishment Ottawa

PHYSICAL PROCESSES IN AN ARCTIC FJORD

R. A. Lake and E. R. Walker, Frozen Sea Research Group, Ocean and
Aquatic Affairs, Patricia Bay

Coffee (1500 - 1530)

SESSION 4 *Planetary Boundary Layer, Part II,
Mesoscale Structures* Wed 1530 – 1700

Chairman: G. A. McBean Location: IRC 2

A PLANETARY BOUNDARY LAYER STUDY IN THE MACKENZIE VALLEY

G. T. Csanady and B. Pade, Woods Hole Oceanographic Institution,
Woods Hole, Massachusetts

OBSERVATION OF THE MULTIPLE PASSAGE OF A QUASISTATIONARY FRONT

R. C. Bennett and R. List, University of Toronto

**A NUMERICAL MODEL OF THE SEA-BREEZE PHENOMENON ASSOCIATED WITH
A LAKE OR GULF**

W. L. Physick, Atmospheric Environment Service, Downsview

CUMULUS CLOUDS AND FOREST FIRES

G. A. Isaac, Atmospheric Environment Service, Downsview

J. I. MacPherson, National Aeronautical Establishment, Ottawa

L. B. MacHattie, Canadian Forestry Service, Ottawa

SESSION 5 *Cloud Physics* Wed 1530 – 1700

Chairman: W. F. Hitschfeld Location: IRC 1

MICROANALYSIS OF A FOG

C. East and M. J. E. Gauthier, Université du Québec à Montréal

**MULTIPLICATION EFFECTS IN THE PRODUCTION OF CONDENSATION NUCLEI
BY EVAPORATION OF SOLUTION DROPLETS**

J. V. Iribarne, University of Toronto

MODELLING PRECIPITATION PROCESSES WITH STABLE ISOTOPES

R. B. Charlton, J. Gray and H. Sandhu, University of Alberta

**ON PARAMETERIZATION OF CONDENSATION IN ABSOLUTELY STABLE STRAT-
IFICATIONS**

H. Sundqvist, Atmospheric Environment Service, Dorval

SESSION 6 *Physical Oceanography – Part II
Water Movement* Wed 1530 – 1700

Chairman: P. H. LeBlond Location: IRC 3

BAROCLINIC INSTABILITY IN THE DENMARK STRAIT OVERFLOW

Peter C. Smith, Bedford Institute of Oceanography, Dartmouth

**CURRENTS AND TRANSPORT IN THE MAIN ENTRANCES TO THE GULF OF ST.
LAWRENCE**

Mohammed I. El-Sabh, Université du Québec à Rimouski, Québec

THE MIXING OF WATER MASSES OFFSHORE OF THE NEWFOUNDLAND GRAND BANKS

R. A. Clarke and R. F. Reiniger, Bedford Institute of Oceanography, Dartmouth

COASTAL CIRCULATION AND LONG TERM TEMPERATURE VARIABILITY OFF EASTERN CANADA AND THE NORTHEASTERN UNITED STATES

K. Drinkwater, Bedford Institute of Oceanography, Dartmouth

RECENT WORK IN PRODUCING PICTURES OF SEA SURFACE TEMPERATURE FROM NOAA AND SMS SATELLITES

R. Legecki, NOAA, Washington, U.S.A. (c/o Jim Gower, MSd Pacific, Victoria)

Thursday Morning, 29 May 1975

SESSION 7 *Dynamic Meteorology, Part I* Thu 0830 – 1000
 Forecast Applications

Chairman: J. L. Knox Location: IRC 2

USE OF ENERGY CONCEPTS IN THE PREDICTION OF MAJOR CYCLOGENESIS

D. Gardner, Atmospheric Environment Service, Downsview

EFFECTS OF CONVECTIVE PARAMETERIZATION OF LATENT HEAT IN THE DPR-PE MODEL

S. M. Daggupaty, Atmospheric Environment Service, Dorval

PROGNOSTIC VERSUS DIAGNOSTIC CALCULATIONS OF SURFACE STRESS FOR GCM'S OR FORECAST MODELS

Y. Delage, Atmospheric Environment Service, Dorval

BRANCH-POINT OPPORTUNITIES FOR SYNOPTIC SCALE WEATHER MODIFICATION

D. Davies, Atmospheric Environment Service, Dorval

Coffee (1000 – 1030)

SESSION 8 *Physical Oceanography – Part III* Thu 0830 – 1020
 Seiches and Internal Waves

Chairman: C. R. Mann Location: IRC 1

SEICHE EXCITATION IN A COASTAL BAY BY EDGE WAVES TRAVELLING ON THE CONTINENTAL SHELF

D. D. Lemon, P. H. LeBlond and T. R. Osborn, Institute of Oceanography, University of British Columbia, Vancouver

SEICHES IN THE NORTHWEST ARM OF HALIFAX HARBOUR

D. Stucchi, Institute of Oceanography, Dalhousie University, Halifax

LONGSHORE CURRENT GENERATION BY INTERNAL WAVES IN GEORGIA STRAIT

Richard E. Thomson, Ocean and Aquatic Affairs, Pacific Region, Victoria

J. R. Marko and R. E. Thomson, Ocean and Aquatic Affairs, Pacific Region,
Victoria

B. A. Hughes, Defence Research Establishment Pacific, Victoria

Coffee (1020 – 1050)

Chairman: J. M. Bowers Location: IRC 3

A. R. Coote and I. W. Duedall, Bedford Institute of Oceanography, Dartmouth

J. M. Bowers, Bjørn Sundby and P. A. Yeats, Bedford Institute of Oceanography, Dartmouth

R. C. Cooke, Institute of Oceanography, Dalhousie University Halifax

M. Silverberg, Université du Québec, Rimouski

Coffee (1030 – 1100)

Chairman: C. East Location: IRC 2

R. L. Berry, D. M. Whelpdale and H. A. Wiebe, Atmospheric Environment Service, Downsview

H. A. Wiebe, Atmospheric Environment Service, Downsview

M. P. Olson, Atmospheric Environment Service, Downsview

R. K. R. Vupputuri, Atmospheric Environment Service, Downsview

Lunch (1200 – 1330)

SESSION 11 *Physical Oceanography – Part IV* Thu 1050 – 1200
Ocean Turbulence and Microstructure

Chairman: C. R. Mann Location: IRC 1

AN INVESTIGATION OF THE OCCURRENCE OF OCEANIC TURBULENCE, WITH
RESPECT TO FINE STRUCTURE

A. E. Gargett, Ocean and Aquatic Affairs, Pacific Region, Victoria

OCEANIC MEASUREMENTS OF ENERGY DISSIPATION

William R. Crawford and Thomas R. Osborn, Institute of Oceanography
University of British Columbia, Vancouver

HORIZONTAL COHERENCE OF TEMPERATURE MICROSTRUCTURE

J. A. Elliott and N. S. Oakey, Bedford Institute of Oceanography Dartmouth

Lunch (1200 – 1330)

SESSION 12 *Interaction of Biological,* Thu 1030 – 1200
Chemical and Physical
Processes, Part I

Chairman: T. Parsons Location: IRC 3

SEA COLOUR MEASUREMENTS WITH A MULTICHANNEL SPECTROMETER

R. A. Neville, Ocean and Aquatic Affairs, Pacific Region, Victoria

OCEAN SURFACE TEMPERATURE STRUCTURE FROM NOAA SATELLITE IMAGERY

J. F. R. Gower, D. Truax, S. Tabata, Ocean and Aquatic Affairs, Pacific Region,
Victoria

PHYTOPLANKTON PATCHES AND THE PHYSICAL WORLD

Ronald C. Wiegand, Institute of Oceanography, University of British Columbia,
Vancouver

SPATIAL VARIABILITY OF PHYTOPLANKTON

K. Denman, Bedford Institute of Oceanography, Dartmouth

Lunch (1200 – 1330)

Continued after Lunch as Session 15

Thursday Afternoon, 29 May 1975

SESSION 13	<i>Urban Meteorology</i>	Thu 1330 – 1500
Chairman:	R. E. Munn	Location: IRC 2

THE URBAN BOUNDARY LAYER OVER NEW YORK CITY
R. D. Bornstein, San Jose State University, California

A PREDICTIVE STUDY OF THE EFFECT OF ARTIFICIAL HEAT GENERATION ON
URBAN CLIMATE IN HONG KONG
J. D. Kalma, C.S.I.R.O., Canberra, Australia

THE MESOSCALE EFFECTS OF NEW YORK CITY ON SYNOPTIC SCALE FRONTS
T. Loose and R. D. Bornstein, San Jose State University, California

ON THE COUPLING BETWEEN STREET-LEVEL AND MESOSCALE BOUNDARY
LAYER URBAN HEAT ISLANDS
T. R. Oke, University of British Columbia

Coffee (1500 – 1530)

SESSION 14	<i>Air Sea Interaction, Part I</i>	Thu 1330 – 1500
Chairman:	S. D. Smith	Location: IRC 1

STATISTICAL RELATIONSHIPS BETWEEN WIND-STRESS AND MARINE
CLIMATOLOGICAL FACTORS IN THE PACIFIC SUB-ARCTIC OCEAN
W. Percy Wickett, Fisheries and Marine Service, Pacific Biological
Station, Nanaimo

WAVE ACTION IN RELATION TO WINDS AT THE PACIFIC ENVIRONMENT
INSTITUTE, WEST VANCOUVER, B. C.
Michael Waldichuk, Pacific Environment Institute, West Vancouver

THE UPPER LAYER OCEAN STRUCTURE IN THE NORTH PACIFIC
M. Miyake, Institute of Oceanography, University of British Columbia,
Vancouver

CHEMICAL ASPECTS OF AIR-SEA INTERACTIONS: A BRIEF OVERVIEW
E. P. Jones, Bedford Institute of Oceanography, Dartmouth

Coffee (1500 – 1530)

Continued after Coffee as Session 17

Chairman:

T. Parsons

Location: IRC 3

**PHYSICAL PROCESSES BEARING UPON THE PRODUCTIVITY IN THE ST. LAWRENCE
GULF-ESTUARY SYSTEM**Paul Greisman and Grant Ingram, Marine Sciences Centre, McGill University,
Montreal**TRANSPORT OF NUTRIENTS IN THE LOWER ST. LAWRENCE ESTUARY**

M. Sinclair, J. R. Brindle, M. El-Sabh, Université du Québec, Rimouski

**PHYTOPLANKTON DISTRIBUTION IN AN ESTUARINE ENVIRONMENT WITH STRONG
INTERNAL TIDES**

M. Sinclair, J. P. Chanut, Université du Québec à Rimouski, Québec

FEEDING OF PSEUDOCALANUS MINUTUS ON LIVING AND NON-LIVING PARTICLES

S. A. Poulet, INRS-Océanologie, Rimouski, Québec

Coffee (1500 – 1530)

Continued after Coffee as Session 18

SESSION 16*Climatic Change*

Thu 1530 – 1720

Chairman:

S. Orvig

Location: IRC 2

THE CHANGING CLIMATE AND ITS IMPACT ON FOOD PRODUCTIONM. K. Thomas and G. A. McKay, Atmospheric Environment Service,
Downsview**RESEARCH ACTIVITIES IN CLIMATIC CHANGE**G. J. Boer and B. W. Boville, Atmospheric Environment Service,
Downsview**CLIMATIC TRENDS IN THE NORTHERN HEMISPHERE**W. S. Harley and T. Jakobsson, Atmospheric Environment Service,
Downsview**FLUCTUATIONS IN THE NORMAL TEMPERATURE TREND AT SELECTED
CANADIAN STATIONS**

G. S. Strong and M. L. Khandekar, University of Alberta

**CLIMATIC FLUCTUATIONS IN THE FRASER RIVER DELTA – STEVESTON,
BRITISH COLUMBIA 1896 – 1974**

D. G. Schaefer, Atmospheric Environment Service, Vancouver

SESSION 17 *Air Sea Interaction, Part II* Thu 1530 – 1700

Chairman S. D. Smith Location: IRC 1

VARIATION OF THE SEA SURFACE DRAG COEFFICIENT WITH WIND SPEED
S. D. Smith and E. G. Banke, Bedford Institute of Oceanography, Dartmouth

THE INFLUENCE OF WIND GENERATED WAVES ON THE WIND PROFILE
Mark A. Donelan, Lakes Research Division, Canada Centre for Inland Waters, Burlington, Ontario

A STUDY OF THE PRESSURE FLUCTUATION PROFILE ABOVE WIND-GENERATED SEA WAVES
F. W. Dobson and J. A. Elliott, Bedford Institute of Oceanography, Dartmouth

RESONANT WAVE/WAVE INTERACTIONS ON A BEACH
A. J. Bowen, Department of Oceanography, Dalhousie University, Halifax

A NEW LOOK AT THE CLIMATOLOGICAL FREQUENCIES OF MARINE FOG
R. J. Renard, J. S. Daughenbaugh and R. E. Englebretson, Dept. of Meteorology, Naval Postgraduate School, Monterey, California

SESSION 18 *Interaction of Biological Chemical and Physical Processes, Part III* Thu 1530 – 1700

Chairman: T. Parsons Location: IRC 3

THE DISTRIBUTION OF COPPER MINE TAILINGS IN TWO BRITISH COLUMBIA COASTAL INLETS: AN AGE-IMPACT COMPARISON
J. A. J. Thompson and D. W. Paton, Pacific Environment Institute Fisheries and Marine Service, West Vancouver

CIRCULATION PATTERN AS A FACTOR IN THE NUTRIENT SUPPLY SYSTEM IN THE GULF OF ST. LAWRENCE
Mohammed I. El-Sabh, Université du Québec à Rimouski, Québec

A MODEL OF PHYTOPLANKTON DISTRIBUTION AT THE MOUTH OF THE FRASER RIVER
B. D. de Lange Boom, P. H. LeBlond, T. R. Parsons, Institute of Oceanography, University of British Columbia, Vancouver

Friday Morning, 30 May 1975

SESSION 19 *Air Pollution Meteorology, Part II – Urban and Regional* Fri 0830 – 1000

Chairman: J. Maybank Location: IRC 2

SUSPENDED PARTICULATE CONCENTRATIONS: SPATIAL CORRELATIONS IN THE DETROIT-WINDSOR AREA
R. E. Munn, Atmospheric Environment Service, Downsview

AN APPLICATION OF A SIMPLE ADVECTIVE POLLUTION MODEL TO THE CITY OF CALGARY

D. M. Leahey and M. J. E. Davies, Western Research and Development Ltd., Calgary

PRELIMINARY RESULTS ON THE VERTICAL TEMPERATURE STRUCTURE OF THE VANCOUVER AREA

P. W. Suckling, D.K.G. Love, W. F. Tanner and R. E. Hardy, University of British Columbia

ON THE STRAIT OF CANSO FIELD STUDY

F. H. Fanaki, Atmospheric Environment Service, Downsview

Coffee (1000 – 1030)

SESSION 20

*Dynamic Meteorology, Part II
General*

Fri 0830 – 1000

Chairman:

P. E. Merilees

Location: IRC 1

ACOUSTIC GRAVITY WAVE EMISSION FROM SEVERE CONVECTIVE STORMS

J. E. Donegani and W. R. Peltier, University of Toronto

A STUDY ON LEE CYCLOGENESIS AND BEHAVIOUR OF UPPER AIRFLOWS IN LARGE SCALE MOUNTAINS

Y-S. Chung, Atmospheric Environment Service, Downsview

A DETAILED CASE ANALYSIS OF THE ALBERTA CHINOOK

P. F. Lester, University of Calgary

THE FATA MORGANA AND THE FATA BROMOSA

A. B. Fraser and W. H. Mach, Pennsylvania State University, University Park, Pennsylvania

Coffee (1000 – 1030)

SESSION 21

*Estuarine Processes, Physical and
Chemical, Part I*

Fri 0830 – 1000

Chairman:

D. Farmer

Location: IRC 3

ANNUAL AND LONGER TERM VARIATIONS OF DEEP WATER PROPERTIES IN THE COASTAL WATERS OF SOUTHERN BRITISH COLUMBIA

G. L. Pickard, Institute of Oceanography, University of British Columbia, Vancouver

THE HEAT BUDGET STUDY OF PENDRELL SOUND

W. R. Buckingham, Institute of Oceanography, University of British Columbia, Vancouver; D. Farmer, Ocean and Aquatic Affairs, Pacific Region, Victoria; M. Miyake, Institute of Oceanography, University of British Columbia, Vancouver

CURRENT METER RECORDS FROM HOWE SOUND

W. H. Bell, Pacific Environment Institute, West Vancouver

SURFACE WATER MOVEMENT IN A FJORD, HOWE SOUND, BRITISH COLUMBIA

Joseph R. Buckley, Institute of Oceanography, University of British Columbia,
Vancouver

Coffee (1000 – 1030)

Continued after Coffee as Session 24

SESSION 22 *Forest and Agricultural Meteorology* **Fri 1030 – 1220**

Chairman: L. J. Fritschen **Location:** IRC 2

**ON THE TRANSITION FROM WATER TO AIR IN MICROMETEOROLOGICAL
MODELLING**

P. H. Schuepp, K. D. White and V. V. Tran, McGill University

LABORATORY AND FIELD STUDIES OF PLANTS UNDER THERMAL STRESS

N. Barthakur, McGill University

FACTORS AFFECTING THE SURFACE RESISTANCE OF A FOREST CANOPY

T. A. Black and C. S. Tan, University of British Columbia

**EDDY CORRELATION AND FLUXATRON ESTIMATES OF SENSIBLE HEAT
FLUX OF A DOUGLAS-FIR CANOPY**

H. R. Holbo, L. J. Fritschen and M. O. Smith, University of Washington

AGRICULTURAL CLIMATE OF THE SASKATOON AREA

D. A. Bernachi, Atmospheric Environment Service, Saskatoon

Lunch (1220 – 1330)

SESSION 23 *Hail* **Fri 1030 – 1200**

Chairman: A. J. Chisholm **Location:** IRC 1

ON THE CALIBRATION OF HAILPADS

E. P. Lozowski and G. S. Strong, University of Alberta

**OPERATIONAL CLOUD SEEDING AND RESEARCH ACTIVITIES IN SUPPORT
OF THE ALBERTA HAIL PROJECT**

K. L. Grandia, Intera Environmental Consultants Ltd., Calgary

FIELD MEASUREMENTS OF HAILSTONE AERODYNAMICS

E. P. Lozowski and A. G. Beattie, University of Alberta

AN AXISYMMETRIC HAILSTORM MODEL

M. English, Alberta Research Council, Edmonton

Lunch (1200 – 1330)

SESSION 24 *Estuarine Processes, Physical and Chemical, Part II* Fri 1030 – 1200

Chairman: D. Farmer Location: IRC 3

ORGANIC CARBON IN THE ST. LAWRENCE ESTUARY
M. Khalil, Université du Québec à Rimouski, Québec

CHARACTERISTICS OF A MESOSCALE FRONT IN THE ST. LAWRENCE ESTUARY
R. Grant Ingram, Marine Sciences Centre, McGill University, Montreal

THE NATURE AND SIGNIFICANCE OF INTERNAL TIDES IN THE ST. LAWRENCE ESTUARY
W. D. Forrester, Bedford Institute of Oceanography, Dartmouth

SUB-SURFACE CURRENTS IN THE STRAIT OF GEORGIA, WEST OF STURGEON BANK
Phillip Y. K. Chang, Institute of Oceanography, University of British Columbia, Vancouver

Oceanography Luncheon (1200 – 1400)

Friday Afternoon, 30 May 1975

SESSION 25 *Remote Sensing* Fri 1330 – 1500

Chairman: J. A. Davies Location: IRC 2

THE ANALYSIS OF HAILSWATHS BY INFRA-RED RADIOMETRY
K. Markey and G. Goyer, Alberta Research Council, Edmonton

ON THE ANALYSIS OF SCANNING RADIOMETER IMAGERY IN THE ARCTIC WINTER
E. R. Reinelt, University of Alberta

HOW TO TAKE AN ATMOSPHERIC TEMPERATURE SOUNDING TO A HEIGHT OF FIVE KILOMETRES BY WATCHING THE SETTING SUN
A. B. Fraser and R. Hemler, Pennsylvania State University, University Park, Pennsylvania

THE QUADRA WEATHER RADAR SYSTEM
E. Ballantyne and G. Austin, McGill University

Coffee (1500 – 1530)

SESSION 26 *Dynamic Meteorology, Part III* **Fri 1330 – 1500**
Models

Chairman: R. Asselin **Location:** IRC 1

**A TWO-DIMENSIONAL GENERAL CIRCULATION MODEL OF THE ATMOSPHERE
INCORPORATING DIABATIC EFFECTS AND SURFACE FRICTION**

S. F. Woronko, N. MacFarlane and R. K. R. Vupputuri, Atmospheric Environment
Service, Downsview

**BAROCLINICALLY UNSTABLE EIGENMODES OF A TWO-LEVEL SPHERICAL
ATMOSPHERIC MODEL**

H. Warn, Atmospheric Environment Service, Dorval

MODELLING OF STANDING WAVES WITH NON-LINEAR EFFECTS

J. Spagnol, McGill University

**TREATISE OF THE HYBRID MODE OF A DIFFUSE AND SPECULAR REFLECTOR
ON COMPUTING THE EMERGENT RADIATION BY USING THE 'ADDING' METHOD**

T. Takashima, C. I. Taggart and E. G. Morrissey, Atmospheric Environment
Service, Downsview

Coffee (1500 – 1530)

SESSION 27 *Dynamics of Inshore and Inland* **Fri 1420 – 1500**
Waters, Part I

Chairman: G. K. Rodgers **Location:** IRC 3

LONG-TERM CIRCULATION IN SHALLOW SEAS

G. T. Csanady, Woods Hole Oceanographic Institution, Woods Hole,
Massachusetts, U.S.A.

SHORT PERIOD WATER MOTIONS IN THE NEARSHORE ZONE

Paul F. Hamblin, Physical Processes Unit, Canada Centre for Inland
Waters, Burlington, Ontario

Coffee (1500 – 1530)

Continued after Coffee as Session 30

SESSION 28 *Air Pollution Meteorology, Part III –* **Fri 1530 – 1700**
Local Dispersion

Chairman: J. H. Emslie **Location:** IRC 2

**ON THE DISTURBANCE OF THE ATMOSPHERIC ELECTRIC FIELD CAUSED
BY AN ISOLATED POINT SOURCE**

S. R. Shewchuck, Saskatchewan Research Council, Saskatoon

DISPERSION OF AgI IN A MOUNTAIN VALLEY

J. D. Reid, Colorado State University, Fort Collins, Colorado

FATE OF SO₂ IN THE ATMOSPHERE FROM SOUR GAS PLANTS

R. D. Rowe, University of Calgary

**DOWNWIND DRIFT, DEPOSITION AND HAZARD ESTIMATION FROM GROUND
SPRAY APPLICATION OF HERBICIDES**

J. Maybank, K. Yoshida, Saskatchewan Research Council, Saskatoon; and
R. Grover, Canada Agriculture, Regina

SESSION 29

GATE

Fri 1530 - 1700

Chairman:

R. J. Polavarapu

Location: IRC 1

SPATIAL VARIABILITY IN THE TROPICAL MARINE BOUNDARY LAYER

D. S. Davison and R. E. Mickle, Atmospheric Environment Service,
Downsview

THE PBL STRUCTURE IN THE GATE FIRST PHASE

D. Hume and M. Miyake, University of British Columbia

**A COMPARATIVE STUDY OF MARITIME TROPICAL AND TEMPERATE
CONTINENTAL PRECIPITATION LINES**

G. Austin and M. Haynes, McGill University

TROPICAL CUMULUS CLOUD POPULATION AND ITS PARAMETERIZATION

Han Ru Cho, University of Toronto

SESSION 30

***Dynamics of Inshore and Inland
Waters, Part II***

Fri 1530 - 1700

Chairman:

G. K. Rodgers

Location: IRC 3

INTERNAL SURGES

D. Farmer and C. Lee, Ocean and Aquatic Affairs, Pacific Region, Victoria

LONG WAVE PROPAGATION IN CHANNELS OF NON-UNIFORM DEPTH

Paul H. LeBlond, Institute of Oceanography, University of British Columbia,
Vancouver

TIDES IN GULFS

Christopher Garrett, Department of Oceanography, Dalhousie University,
Halifax

TIDE INDUCED RESIDUAL CURRENT IN MINAS CHANNEL AND MINAS BASIN

Kim-Tai Tee, Department of Oceanography, Dalhousie University, Halifax

ABSTRACTS

Session 1 Planetary Boundary Layer — Part I, Turbulence

THE APPROACH TO LOCALLY ISOTROPIC TURBULENCE

G. A. McBean and J. A. Elliott

Measurements of the fluctuations of wind velocity, temperature and pressure were made in the atmospheric surface layer over a prairie grassland. The turbulence in such a flow is anisotropic except for the smaller scales where local isotropy may exist. The variance budgets of the three components of turbulent velocity were evaluated and the important source and sink terms identified. The transfers of energy between components were estimated from the velocity-pressure data.

The spectrum or cross-spectrum for each important term were computed so the contributions from different scales can be measured. The transfers of energy between scales were deduced. The data will be presented to investigate the approach towards local isotropy. The time resolution constraints of the equipment prevented an investigation of the local isotropic range.

The variation of the results with different atmospheric stability conditions will be presented.

STOCHASTIC CHARACTER OF STRAINING MOTION IN 2-D TURBULENCE

M. Shabbar

Large-spatial-scale amplitude variations of the turbulent vorticity arising from baroclinic instability produce a coordinated strain over a large region of the flow. A working hypothesis, postulating turbulent vorticity to be convected about by strained velocity, has been utilized to calculate the energy and enstrophy flux functions. Also the equilibrium energy spectrum for anisotropic turbulence is deduced.

GEOMETRIC SIMILARITY FOR THE TEMPERATURE FIELD IN THE UNSTABLE ATMOSPHERIC SURFACE LAYER

D. S. Davison

Davenport's geometric similarity was applied to the temperature field in the unstable atmospheric surface layer for displacements in all three orthogonal directions. Some of the assumptions inherent in geometric similarity were not satisfied. Two regimes, plume scales and larger scales, having different decay constants were observed. The use of local mean wind speed and direction is not valid.

The decay constants for lateral displacements are over 50 times as large as for vertical displacements. The problems due to these large decay constants for lateral displacements in the application of geometric similarity to the temperature field and by analogy the wind field are discussed.

THE VARIABILITY OF TURBULENCE STATISTICS IN THE PBL OVER THE CANADIAN PRAIRIES

D. Davidson and M. Miyake

The turbulence statistics up to 600 meters of the atmospheric Planetary Boundary Layer (PBL) under unstable conditions will be presented. The predictive formula of height dependent statistics as to the spectra level and variance of temperature,

humidity and downwind velocity will be discussed as a method to extend the constant flux layer model to the deeper layer of the PBL.

Session 2 Applied Meteorology

THE IMPORTANCE OF CLIMATE TO RECREATION – TOURISM FACILITY PLANNING R. B. Crowe

Recreation and tourism represent a significant facet of our culture. The economic importance of climate in recreation – tourism planning is becoming more obvious from year to year with diminishing land availability and increasing costs. The Atmospheric Environment Service has taken the initiative in preparing a number of recreation – tourism climatic studies for both large geographical areas and individual National Parks. A brief history of the development of these studies will be given.

Three aspects of recreation climate will be discussed: regional access, local access and outdoor activity climate. The emphasis will be on the latter aspect, and typical factors affecting recreation climate and a classification of major recreation types according to their dependence on climate will be presented.

A two-seasonal approach to recreation climate will be given. The winter and summer seasons are defined by median dates of first and last one-inch of snow cover, with a two-week "drying-up" period arbitrarily separating winter and summer. The summer season is subdivided into three periods, a high summer when the mean daily maximum temperature is greater than 18°C (65°F) and adjacent spring and autumn shoulder periods. Maps of beginning, ending and duration of the recreation seasons across Canada will be presented.

CLIMATIC SUITABILITY FOR OUTDOOR RECREATION AND TOURISM ON THE CANADIAN PRAIRIES J. M. Masterton

One of the most significant factors affecting outdoor recreation and tourism is "weather". Until recently, however, recreation studies concerned with the planning and development of recreational facilities and resources have largely ignored any climatic input, perhaps because perception of and reaction to weather is so subjective and individual.

An attempt to quantify such concepts as "acceptable weather" for a variety of outdoor recreational activities has now been made, and examples will be given from a recently completed study of the recreation climate of the Canadian Prairies. The great number of outdoor pastimes were grouped according to general similarities of necessary suitable weather. Specific climatic criteria for these groups of activities were established, and climatic data for over 70 locations were analyzed, using both hourly and synoptic data. The computer printout provided the percentage of time during one-third-month periods throughout the year that the climate is suitable for each of the activity groups. Examples of charts for individual locations and maps of regional variations of suitability for each of the activity groups will be shown.

EMPLOYING WEATHER DATA TO REDUCE FUNGICIDE USAGE ON CARROTS T. J. Gillespie and W. J. Langenberg

Vegetable crops are often sprayed on a regular schedule to protect them from disease. During periods when the weather is not suitable for disease, this practice wastes growers' time and money and also causes an unnecessary addition of pesti-

cides to the environment. In an attempt to schedule sprays more rationally, we have defined the weather required for a successful attack by *Alternaria dauci* spores which blight carrot foliage. Carrots were chosen because they are a high value crop often grown intensively on relatively small, flat areas of organic soil so that observing and forecasting schemes are not complicated by mesoscale variations in weather. Other crops of interest regarding spray scheduling schemes include potatoes, tomatoes, onions, celery, strawberries, and many tree fruits.

Controlled environment and field studies have identified germination and leaf penetration by the spores as critical phases in the life cycle of *A. dauci*. The environmental factors most influential on these phases are sunshine, temperature, and the duration of leaf wetness. Progress of this disease is described by a type of sigmoid curve equation where the rate constant governing the curve's shape is adjusted each day according to the weather.

A spray scheduling scheme based on this model has successfully maintained disease control on test plots while cutting fungicide usage in half. Over the 800 hectares (2000 acres) of land planted to carrots in the Bradford Marsh (50 km north of Toronto, Ontario) where we hope to run our scheme on an operational basis in 1975, this represents a reduction of 24 tonnes per season in chemical input to the environment.

THE ENERGY BUDGET OF AN ARID AREA AS AN INDICATOR OF POTENTIAL AGRICULTURAL WATER USE AND ITS ROLE IN CLIMATIC CHANGE

E. Vowinkel and S. Orvig

The energy budget EBBA is used to compute surface and atmospheric energy budget terms for each day of a year for a number of stations in Sudan (Khartoum, Wau, El Fasher, Juba). The results are compared with the energy budget for an irrigated (completely saturated) land surface at the same localities.

The possible areal extent is determined of a continuously irrigated surface at each of the localities, and the resultant climate change (air mass modification) is assessed. The optimum production of three crops (sugar cane, cotton, rice) is ascertained for the various areas, based on the respective water consumption requirements of these plants at different times of the year.

Session 3 Physical Oceanography — Part I, The Arctic

PHYSICAL OCEANOGRAPHY OF THE SOUTH-EASTERN BEAUFORT SEA, 1974

B. R. de Lange Boom and R. H. Herlinveaux

During the month of August 1974, some oceanographic features of the south-eastern Beaufort Sea were studied. All measurements were taken in waters less than 200m deep, i.e., within the Arctic surface water. Conditions were not "typical" due to unusually heavy ice concentrations. In the nearshore waters of the Mackenzie River area, stratification was more pronounced than in offshore areas of the Arctic Ocean. The water column can be divided into two regions: the top layer (<10 m deep) which was brackish (salinity <10‰) and warm (temperature >0°C) and the lower layer with salinities >30‰ and temperatures <-1°C. The top layer was generally very turbid due to the Mackenzie River discharge while the lower layer was relatively clear, except close to the bottom where a turbid layer was found. This year the top layer was generally thicker, less saline and lower in temperature than in previous years. One can attribute this to the combined effect of north-west winds and confinement by the ice. The deep water showed much less variability in space and time than the upper layer where temperature layering

was found in the presence of ice. A temperature minimum (-1.6°C) was found at depths between 20 m and 40 m. Direct current measurement indicated the current structure was also divided into two regions by the pycnocline. Under easterly or westerly winds (predominant directions), the large scale surface water motions are reasonably well known for open water conditions but this is not true under the conditions of winter ice cover. Plans are underway to investigate this aspect.

VOLUME AND HEAT TRANSPORT THROUGH NARES STRAIT AND SOME PROBLEMS IN BAFFIN BAY

H. E. Sadler

The author has carried out a series of observations of currents, water quality and temperature in Nares Strait. The observations are briefly described and the resulting values for mass and heat transport are compared with previous estimates for Nares Strait and with the total fluxes into the Arctic Ocean.

The water structure in Nares Strait is then described with reference to the waters of Baffin Bay and a possible origin for Baffin Bay Bottom Water is suggested. The requirements for further observations in the area, to be made during both winter and summer, are then discussed.

NEAR-SURFACE CURRENTS IN ROBESON CHANNEL

R. K. Chow

Results of near-surface current measurements to a depth of 75 m below the fast ice in Robeson Channel obtained by a two-dimensional array of current meters in a cross-section of the channel are described. The currents are principally semi-diurnal and diurnal, with two other fairly intense oscillations of periods approximately 8.2 and 6.1 hours. The currents also separate into two layers. In the top layer to a depth of 50 m, the velocity vectors rotate in a counter-clockwise direction whereas the rotation is clockwise in the lower layer. At a given depth, both the axial and the cross-channel currents increase to the right of the longitudinal flow during the ebb and flood of the tide, a characteristic reminiscent of the current profile associated with Kelvin waves in a homogeneous body of water in a channel. Accordingly, this profile is extended qualitatively to a layered channel with an interface at the level of sharp discontinuity in density. The resulting vertical and lateral velocity distributions exhibit the prominent features of the observed near-surface currents. The non-tidal oscillations of periods 8.2 and 6.1 hours are conjectured to originate from internal oscillations of two interfaces, one at a depth of about 50 m and the other probably at 150 m. Future field works to study these phenomena further are discussed.

PHYSICAL PROCESSES IN AN ARCTIC FJORD

R. A. Lake and E. R. Walker

Oceanographic data have been collected for the past six years in d'Iberville Fjord in northern Ellesmere Island. The fjord is covered by sea ice eleven months of each year. Icebergs are calved by an active glacier debouching into the eastern end of the fjord.

A sill with maximum depth of 200 m lies across the fjord entrance while depths within extend to 600 m. Input of fresh water is confined to spring run off from land, sea ice and iceberg melt from June through August, and occasional pulses of run-off in mid-summer caused by heavy rains.

The circulation appears to be minimal in the 'hole' below sill level. Above an estuarine circulation is seen in summer. In winter only weak currents have been

measured and the water structure remains highly stratified. Marked cooling of water by the floating ice shelf at the glacier snout has been observed to a depth of 100 m.

Session 4 Planetary Boundary Layer — Part II, Mesoscale Structures

A PLANETARY BOUNDARY LAYER STUDY IN THE MACKENZIE VALLEY

G. T. Csanady and B. Pade

Detailed wind velocity profiles were obtained by means of a rocket-sonde technique to a height of about 700 m. at a site in the Canadian Northwest Territories. Less detailed temperature observations were also made using a balloon sonde. The site was some 100 km east of the easternmost range of the Rocky Mountains. The observations took place in mid-February when the overall static stability of the air above ground was considerable.

The results showed the presence of an arctic, atmospheric "thermocline" some 500 m above ground, which sloped up or down considerably, with the generators of isothermal surfaces usually parallel to the nearby mountains, in the manner of upwelled or downwelled thermoclines in the ocean near shore. There was often strong baroclinic flow parallel to the mountain range. Noticeable frictional effects were confined to a near-ground layer always less than 100 m and mostly no more than 10 m in height. An Ekman type boundary layer could only be identified at all in about one-third of the velocity profiles. The nondimensionalized depth coefficient of such layers was close to 0.1, the geostrophic drag coefficient about $2.5 \cdot 10^{-4}$.

OBSERVATION OF THE MULTIPLE PASSAGE OF A QUASISTATIONARY FRONT

R. C. Bennett and R. List

Acoustic radar studies of the planetary boundary layer show that marked changes in the distribution of thermal turbulence accompany abrupt air mass transitions. Data from the acoustic radar which operated continuously for more than a year at the University of Toronto revealed that the passage of a sharp cold front invariably caused an increase in thermal turbulence while the passage of a warm front resulted in a significant decrease in thermal turbulence.

On January 15, 1974 a massive body of cold air covered the northern half of North America. A quasistationary front marking the leading edge of the cold air stretched from coast to coast. A series of small amplitude short waves moving quickly along the front caused it to move over Toronto three times in less than 24h. The acoustic radar monitored these frontal passages through their influence on the boundary layer thermal turbulence structure. During the second southward motion of the cold air the echo sounding records showed the shape of the leading edge and trailing upper boundary of the front; the extent and internal structure of the mixing zone between the advancing wedge of cold air and the overlying warm air; the location of the upper boundary of the cold air; and the decrease in the extent of the cool mixing layer as the depth of the cold air increased.

The acoustic radar provided insight into the structure and evolution of these frontal passages that could not have been obtained in any other way.

A NUMERICAL MODEL OF THE SEA-BREEZE PHENOMENON ASSOCIATED WITH A LAKE OR GULF

W. L. Physick

In this study, a two-dimensional primitive equations model is used to investigate

the circulations induced by differential heating in the vicinity of a land-locked semi-infinite body of water. The semi-empirical boundary layer formulation of Clarke is used with an expanding σ -grid of fifteen vertical levels. Surface temperature is computed by means of a heat-flux balance equation and a radiation condition is used at the lateral boundaries. For purposes of comparison one run was also made with reflective boundary conditions. Results are obtained for cases of different geostrophic wind, gridlength and water width, and favourable comparisons are made with some Australian observations, the model having been designed for this area.

CUMULUS CLOUDS AND FOREST FIRES

G. A. Isaac, J. I. MacPherson and L. B. MacHattie

During 1974, the Canadian Forestry Service, the Atmospheric Environment Service and the National Aeronautical Establishment began a joint project designed to study the feasibility of suppressing large forest fires by weather modification. Scientists in the USSR report that they are artificially increasing rainfall from cumulus clouds passing over forest fires. If economically feasible, this technique would be useful for controlling forest fires in Canada.

Using an NAE T-33 turbulence research aircraft and an instrumented NAE Twin Otter aircraft, an airborne measurement program was conducted in 1974. Cumulus clouds over forests in Quebec and Ontario were studied. In addition, large forest fires which occurred near the Ontario-Manitoba border in July were examined.

Measurements have been made using a new optical ice particle counter, a cloud particle replicator and an ice nucleus counter. Turbulence measurements were made at the tops and bases of cumuli and at various levels over fires. Turbulent dissipation rates within cloud and out-of-cloud have been calculated. Some observations describing the interaction between fires and clouds have been collected.

The observations and measurements described above have been summarized and the implications with respect to weather modification will be discussed.

Session 5 Cloud Physics

MICROANALYSIS OF A FOG

C. East and M. J. E. Gauthier

By means of a cascade impactor, fog droplet size distributions have been established up and downwind of the Montreal-East industrial sector consisting mainly of oil refineries. Despite the water vapor output from the oil refineries, the distributions surprisingly showed a decrease in the largest droplets with respect to the upwind distribution, which can be attributed to an evaporation due to the release of sensible heat from the whole industrial compound. A simple numerical model shows that a slight decrease of 0.05 percent in relative humidity is sufficient to change the upwind distribution into the downwind distribution in about 60 minutes, the time required for the fog to travel from one spot to the other at the wind velocity.

MULTIPLICATION EFFECTS IN THE PRODUCTION OF CONDENSATION NUCLEI BY EVAPORATION OF SOLUTION DROPLETS

J. V. Iribarne

A sprayer-produced aerosol was studied, using different circuits, a Bricard counter and diffusion batteries for the estimation of size distribution. The total number of condensation nuclei produced increased remarkably with the solute concentration

in the liquid and with dilution of the aerosol with dry air. The first effect is largely non-specific, also occurring with liquid nuclei (glycerine). Both the determinations of number concentrations and of particle size indicate a multiplication process. This process appears to operate during the last stages of evaporation, at humidities far below those at which particles are usually assumed to become dry, and cannot be interpreted in general as crystal fragmentation. The dilution effect is probably related to increases in cloud condensation nuclei concentrations observed in evaporating clouds.

MODELLING PRECIPITATION PROCESSES WITH STABLE ISOTOPES

R. B. Charlton, J. Gray and H. Sandhu

Naturally occurring stable isotopes of hydrogen and oxygen can be used as tracers in the precipitation formation processes. Although this technique has been known for several years, little progress has resulted due to laboratory, field and theoretical difficulties. In the case of hail studies, field sampling of precipitation and water vapour is hazardous and difficult to control. Laboratory analysis requires specialized sample preparation techniques and sophisticated mass spectrometers.

If the O^{18} and D content of the water vapour entering a cloud is known, the O^{18} and D isotope content of the cloud droplets at various in-cloud temperatures can be determined by several models according to the cloud type and precipitation process. If the cloud droplets are frozen to form snow pellets or hailstones, their isotope content is preserved until they reach the ground. If the cloud droplets are incorporated into rain, the evaporation process below the cloud base changes the raindrops' isotope contents.

The results of a preliminary attempt to explain the isotope content of snow pellet samples (potential hail embryos) in terms of their temperature of formation are included.

ON PARAMETERIZATION OF CONDENSATION IN ABSOLUTELY STABLE STRATIFICATIONS

H. Sundqvist

A model for condensational processes in absolutely stable stratifications is developed. The micro-physical processes involved in the formation of clouds and precipitation are parameterized. This is accomplished by assuming that the rate of precipitation is a function of the amount of cloud water. The rate of condensation is a function of relative humidity and moisture-flux convergence. Evaporation from falling rain drops is taken into account.

The relative humidity value at which condensation starts and the relative humidity value that is the eventual steady state value are considered external parameters. These are conceivably mainly functions of geographical location and grid point separation of the model providing the large scale quantities (wind, temperature, moisture) for the parameterization.

Preliminary quantitative tests with the model indicated that it yields reasonable evolution times and water content of clouds as well as giving reasonable precipitation amounts.

Session 6 Physical Oceanography — Part II, Water Movement

BAROCLINIC INSTABILITY IN THE DENMARK STRAIT OVERFLOW

Peter C. Smith

Current meter records and hydrographic data from a section across the Denmark

Strait Overflow south of the sill are analyzed. Temperature sections show a sharp interface between warm Atlantic water near the surface and cold Norwegian deep water which is banked up against the continental slope of Greenland. The most outstanding feature of the velocity and temperature time series is a strong spectral peak at a period of 1.8 days. These oscillations are highly correlated both horizontally and vertically with typical coherences in excess of 0.8. Phase estimates indicate that the downstream and cross-stream velocity components are in quadrature, while cross-stream velocity and temperature perturbations act to reduce the mean potential energy associated with the sloping isotherms.

To explain this low frequency variability, a quasi-geostrophic, two layer model for channel flow with a sloping bottom is developed. The criterion for instability in this system is that the mean velocity shear exceeds the geostrophic velocity scale based on the slope, $\Delta\rho g_s/\rho f$. Using measured values of the shear and other physical parameters, the model is found to be unstable over a limited range of wave lengths and frequencies. The most unstable wave is 80 km long and has a period of 2.1 days in close agreement with the peaks in the current meter spectra.

CURRENTS AND TRANSPORT IN THE MAIN ENTRANCES TO THE GULF OF ST. LAWRENCE

Mohammed I. El-Sabh

Geostrophic currents and volume transport through the main sections of Cabot Strait and St. Lawrence Estuary entrances were calculated and adjusted to satisfy the assumption of zero salt transport through the cross-section. The water movements in Cabot Strait are marked by an outward flow along the Newfoundland side. The horizontal and vertical extensions of the two flows vary from season to season. More than 30% of the outward transport through Cabot Strait is found to be confined to the upper 25 meters off the Cape Breton side, while the inflow from the Atlantic Ocean occupies the whole depth on the Newfoundland side and the deep layers of the section with its maximum rate at depths between 50 and 100 meters. A similar pattern to Cabot Strait has been observed in the St. Lawrence Estuary entrance, with the seagoing flow from the St. Lawrence River in the upper 25 meters along the south shore and the upstream flow along the north shore and in the deep layers. Close agreement was found between the adjusted geostrophic current and direct current measurements at both entrances.

THE MIXING OF WATER MASSES OFFSHORE OF THE NEWFOUNDLAND GRAND BANKS

R. A. Clarke and R. F. Reiniger

Over a three week period in April-May, 1972, approximately 150 hydrographic stations were observed to the south and east of the Newfoundland Grand Banks. In addition, 3 lines comprising a total of 26 current meter moorings were laid across the Gulf Stream, the North Atlantic Current and Flemish Pass. By tying a reference level into the average currents given by the current meters, a circulation pattern was built up for the region. The variations of the oxygen content, silicate concentration and salinity of the water are estimated along various predicted stream paths. These variations are then tested against models of mixing either along and/or across isopycnal surfaces to see if they can be accounted for through consistent and reasonable eddy diffusivities.

COASTAL CIRCULATION AND LONG TERM TEMPERATURE VARIABILITY OFF EASTERN CANADA AND THE NORTHEASTERN UNITED STATES

K. Drinkwater

Correlations between annual catch of coastal commercial species of fish and the environmental factors of sea temperatures and St. Lawrence River discharge have led to an investigation of the relationship between the latter. Examining year to year variability of monthly means, effects of the St. Lawrence River discharge can be traced by correlation analysis with sea temperatures to propagate from the Gulf of St. Lawrence, onto the Scotian Shelf and through the Gulf of Maine at known coastal current drift speeds. Seasonal salinity and transport data lend support to such flow. It is concluded that the Gulf of St. Lawrence to the Gulf of Maine inclusive is an oceanic system and events in the southern parts on time scales of a month or more are not independent of more northerly events. It is not interpreted that the river discharge is the driving force of such an oceanic system but rather influences the water properties within the Gulf of St. Lawrence, which in turn are transported southward.

RECENT WORK IN PRODUCING PICTURES OF SEA SURFACE TEMPERATURE FROM NOAA AND SMS SATELLITES

R. Legecki, NOAA, Washington, U.S.A.

Enhanced satellite pictures can delineate major water masses and the geostationary SMS gives the possibility of making time lapse movies of sea surface currents. Pictures taken at 10 minute intervals, day and night, for a month are being used to make movies of features such as the Labrador Current, the Gulf of Mexico Loop current and the Gulf Stream. An example will be shown.

Session 7 Dynamic Meteorology — Part I, Forecast Applications

USE OF ENERGY CONCEPTS IN THE PREDICTION OF MAJOR CYCLOGENESIS

D. Gardner

Major cyclogenesis cannot occur without the existence of a large supply of available potential energy and a triggering mechanism to initiate the conversion from potential to kinetic energy. Practical techniques, based on the concepts of energy and energy propagation, can be used to anticipate the location, timing, and probably intensity of major cyclonic developments, often 48 hours or more in advance, and the forecasts thus produced are superior to those obtainable from NWP models such as the 6-layer PE. These techniques will be described using the storm of 19-21 October 1974, which caused considerable damage in the Canadian Maritimes, as an example.

EFFECTS OF CONVECTIVE PARAMETERIZATION OF LATENT HEAT IN THE DPR-PE MODEL

S. M. Daggupaty

Real data experiments with the inclusion of the convective parameterization in the DPR multi level primitive σ -equation model are performed. The concept and method of application of a simple convective parameterization scheme following the technique of Kuo is discussed. Selected forecast fields are shown and compared with adiabatic prognoses. Features of the predicted precipitation are also evaluated. The present scheme is judged for its reliability and for the improvement of precipitation forecast.

PROGNOSTIC VERSUS DIAGNOSTIC CALCULATIONS OF SURFACE STRESS FOR GCM'S OR FORECAST MODELS

Y. Delage

The determination of surface stress in large scale models that do not resolve the boundary layer is often done using formulations in which the boundary layer is considered as a succession of equilibrium states (bulk transfer or resistance law). These diagnostic techniques take stability and even baroclinicity into account but they are insensitive to dynamical imbalances created by the diurnal heating cycle or by changes in the pressure gradient. In this study we use the Wangara data to compare the performance of a parameterization of this type with that of a scheme involving a predictive equation in the determination of the surface stress.

BRANCH-POINT OPPORTUNITIES FOR SYNOPTIC SCALE WEATHER MODIFICATION

D. Davies

Some of the worst errors in numerical precipitation forecasts issued by the Canadian Meteorological Centre are associated with what appear to be large scale branch-points in the atmospheric flow patterns. One example of this kind of situation occurs when the 500 mb flow favours baroclinic development in a region where the surface chart contains two incipient vortex centres. In the real atmosphere the two vortices will compete for dominance until the flow around one of them is strong enough to submerge the identity of the other. If the model predicts that the wrong vortex will become dominant, then the observed and predicted precipitation areas may cease to overlap by 24 hours. Other examples include the possible development or non-development of secondary lows on occluded frontal waves; the possible formation or non-formation of cut-off lows from sharp 500 mb troughs; the possibility of cut-off 500 mb lows rejoining or not rejoining the main flow; whether a front is stationary or slow-moving in a region of slack flow; and whether or not a squall line forms ahead of a cold front. In all cases, if the model and the real atmosphere take different branches the precipitation forecast rapidly becomes a bust.

It is conceivable, though by no means proven, that branch-points of this type constitute a minimum limit to the predictability of the atmosphere. If so, they would be an insurmountable barrier to short-term deterministic forecasting. However, there would be a corollary of immense practical consequence. The atmosphere must be extremely sensitive to interference in the neighbourhood of branch-points, so that synoptic scale weather modification would become a feasible enterprise. This has the exciting implication that the operational weather services of the future might evolve into a modification-forecasting mix, rather than towards the unattainable objective of providing perfect forecasts.

Session 8 Physical Oceanography – Part III, Seiches and Internal Waves

SEICHE EXCITATION IN A COASTAL BAY BY EDGE WAVES TRAVELLING ON THE CONTINENTAL SHELF

D. D. Lemon, P. H. LeBlond and T. R. Osborn

Short period (< 1 hour) oscillations are often seen superimposed on tidal curves at Port Renfrew, B. C. In order to determine the nature of these oscillations, time-series of sea-level variation were obtained in Port San Juan: their analysis revealed energy peaks at 36 min and 15 min. A theoretical model of wave excitation of a basin of variable depth fitted to Port San Juan by edge waves travelling on the

shelf accounts reasonably for the observed frequencies. Bottom friction was taken into account to investigate the dependence of seiche amplitude on the amplitude of the shelf waves.

SEICHES IN THE NORTHWEST ARM OF HALIFAX HARBOUR

D. Stucchi

Analysis of digitized tidal records from the Northwest Arm reveals a prominent fundamental mode having a Q of 12 ± 3 , in the period range 34.5 to 37.0 min and a second mode in the period range 11.6 to 13.5 min with a similar Q . These observations agree quite closely with the results of a linear, one-dimensional, numerical model of the Northwest Arm. Two other resonant features in the period ranges 45.5 to 55.5 and 16.1 to 20.0 min evident from spectral analysis are Halifax Harbour modes. The characteristics of the fundamental mode were further investigated with the method of complex demodulation. The results of the analysis reveal, (i) a lower Q for the fundamental mode, (ii) little correlation between frequency of the first mode and either the tidal height or slope, and (iii) little correlation between the amplitude of the first mode and either tidal height or slope. Generation mechanisms for the fundamental mode were also investigated, specifically local wind stress, atmospheric pressure perturbations and general meteorology. There is no obvious "cause and effect" relationship between the activity of the fundamental mode and any of the above generating mechanisms. The generation of the seiches in the Northwest Arm is probably by long-period waves incident on the mouth of Halifax Harbour.

LONGSHORE CURRENT GENERATION BY INTERNAL WAVES IN GEORGIA STRAIT

Richard E. Thomson

Presented in this paper is a derivation of the longshore current generated by breaking lowest mode internal waves in a two layer fluid of slowly shallowing depth, with emphasis on the nearshore region of the Fraser River delta in Georgia Strait. In Particular, it is proposed that such a current, which would have a maximum speed of order $10^4/\mu_v \text{ cm}^3/\text{sec}^2$ (μ_v is the vertical eddy viscosity) and a width of order kilometers based on measured water properties and internal wave characteristics in the Strait, is responsible for the persistent northward flow observed to be associated with the delta in summer. Accordingly, it is suggested that the resultant longshore transport varies seasonally, with greatest transport in the summer and fall when the stratification in the Strait of Georgia is most pronounced.

SPATIALLY PERIODIC LEAD PATTERNS IN THE BEAUFORT SEA

J. R. Marko and R. E. Thomson

Satellite observation of the Beaufort Sea and its neighbouring waters has indicated the occasional presence in the ice cover of very long, narrow leads arranged in grid-like patterns having spatial periodicities on the order of 100 kilometres. The characteristics of these leads will be discussed and consideration given to generating mechanisms involving oceanic topographical Rossby Waves.

EXPERIMENTAL MEASUREMENTS OF THE INTERACTION OF SURFACE AND INTERNAL WAVES

B. A. Hughes

In 1972, internal waves were generated by a ship in Bute Inlet using the 'dead water' effect. Perturbations in the wind wave field resulting from the presence of these

internal waves were measured. The principal signals used to define the interactions were obtained from two surface wave slope components, horizontal internal wave current measured near the surface and wind speed and direction. Using statistical data reduction techniques, the 'sensitivity' of the variance of the wind wave field to internal wave current has been estimated as a function of the wind. Sensitivity is here defined as $d\ln\sigma^2/d(u/c)$ where σ^2 is surface slope variance, u is horizontal internal wave current, and c is internal wave phase speed. The principal results are contained in the numerical estimates of sensitivity and they provide substantiation of the more general observation that the wind wave field is relatively more sensitive to internal wave currents at low wind speeds than in high winds.

An optical device for rapidly measuring surface wave slope was designed for this experiment and details of its operating characteristics will also be given.

Session 9 Chemical Oceanography

PROCESSES LEADING TO THE FORMATION OF NUTRIENT MAXIMA IN THE SOUTH ATLANTIC

A. R. Coote and I. W. Duedall

During the Hudson 70 Expedition to the South Atlantic, thirteen oceanographic stations were occupied between 22°S and the Antarctic Convergence at which silicate, dissolved inorganic phosphate, dissolved nitrate plus nitrite, and oxygen were measured. The nitrate and phosphate profiles show maximums that are always situated about 200 m higher in the water column than the silicate maximum and the oxygen and weak temperature minimums, all three of which exist at essentially the same density surface. According to Richards, however, the oxygen minimum lies above the nitrate and phosphate maximums in most parts of the world ocean. Possible explanations for the observed displacement of these extrema in the South Atlantic are discussed in terms of advective processes.

TRACE ELEMENT CHARACTERISTICS OF SOME WESTERN ATLANTIC WATER MASSES

J. M. Bowers, Bjørn Sundby and P. A. Yeats

The early optimism of marine chemists regarding the use of trace element concentrations to characterize water masses has largely proved unjustified. Although many workers have attempted to interpret trace metal distributions in the marine environment in terms of the physical properties of oceanic waters, in few cases has vigorous proof of significant variations, related to physical concepts, been provided. Recent improvements in analytical technology have enabled relatively precise determinations of iron, manganese, zinc, copper, nickel, cadmium and cobalt to be made in four types of water in the extreme western Atlantic Ocean. Significant differences were found in the respective mean concentrations of *Fe* and *Mn* in Central Atlantic Water, Atlantic Slope Water, inshore surface water and Scotian Shelf deep water. For some of these water masses, the respective mean concentrations of *Zn*, *Cu*, *Ni*, *Cd* and *Co* were also significantly different. The distribution of suspended particulate material, its relationship to the concentrations of particulate *Fe* and *Mn*, and the extent of continental influence upon nearshore waters will also be discussed.

GENERAL FEATURES OF CALCITE DISSOLUTION AT PRESSURE IN SEAWATER

R. C. Cooke

Extensive examination of the calcite-seawater system has shown that the necessary

four controls on this two-phase three component system are pressure, temperature, liquid composition and solid composition. The effect of perturbing each of these variables systematically has been analyzed, and a comprehensive description of the oceanic lysocline and compensation depth has emerged. Carbonate ion is the most important compositional determinant of Mg -calcite stability in the sea, with magnesium ion a close second; the effect of calcium ion changes was essentially nil. Pressure is the prime physical control on this system, and it is proposed that there is a stability field for calcite in the sea which has the lysocline as its lower boundary and which has internal compositional boundaries set by the differential rates of change of the chemical potential of $MgCO_3$ and $CaCO_3$ in solution in each phase with variation of pressure. Below the lysocline the phase rule no longer describes the system and calcite dissolution must proceed.

MODERN SEDIMENTATION IN THE EAST SIBERIAN AND LAPTEV SEAS

M. Silverberg

As more information accumulates from the Arctic the conception of glacier and sea-ice derived gravelly deposits as the dominant shelf sediments, is being replaced by a more precise understanding of Arctic processes. Sedimentological analyses of additional samples from the East Siberian and Laptev Seas confirm the dominance of fine-grained sediments. Among the factors which determine the low energy of sorting and transporting agents are the 8-9 month dense ice cover, the resulting dampening of waves and currents, the low tidal range, the highly seasonal river discharge, its timing with respect to ice break-up, and the gentle river gradients across the broad coastal plain.

River flooding, sometimes spectacular, occurs in the spring when the lower reaches and the sea are still ice-bound. The coarse sediment is dumped at the deltas while the silt and clay are carried seaward as the warmer river inflow gradually helps the break-up of the fast and Arctic pack ice offshore. A weak and probably unsteady counter-clockwise circulation in both seas distributes the suspended material across most of the seas in a low salinity surface layer. Bulk sedimentation of silt and clay occurs in the troughs near the rivers and in the submarine valleys where circulation is weak. The more elevated bank areas are apparently by-passed by all but the coarsest silt grains, and in the western Laptev Sea currents develop strongly enough to maintain a relict sand surface. The persistence of relatively dense ice cover over the banks until long past the spring floods apparently protects the banks from massive influxes of fine-grained sediment. The ice cover may act to dampen the wind-driven circulation and perhaps to impede the inflow of the low salinity surface layer. When the ice clears the circulation may be strong enough to sweep the finer particles off to quieter areas. The central bank sediments of the East Siberian Sea have the typical strong mode of coarse silt but this is diluted with fine silt and clay characteristic of the trough areas. The unusual flooding of the Indigirka River late in the summer could account for this fine material on Central Bank.

The return of winter conditions dampens the circulation, stops the input of river water, and creates a break-down of the stratification. The remaining suspended material is then free to settle over the long winter calm. This may explain the generally high proportions of material finer than 0.5 microns which are present even in the sand sediments of the western Laptev Sea. The near absence of coarse sand and high concentrations of fine clay in the sediments confirms the quiet conditions of sedimentation in these Arctic Seas. Thus ice may play a more significant role as a dampener of circulation than as a raft of sediment.

A FIELD PROJECT FOR TESTING PRECIPITATION SAMPLERS

R. L. Berry, D. M. Whelpdale and H. A. Wiebe

The Air Quality and Inter-Environmental Research Branch of the Atmospheric Environment Service of Canada is currently instituting a Background Air Pollution Monitoring program at selected weather stations in Canada. These stations form part of a WMO network monitoring the atmosphere for long term changes in composition on global and regional scales. A major part of this program involves the collection of precipitation samples which are analyzed to determine their chemical composition. A project was initiated in March of 1974 to study a number of precipitation samplers under field conditions in order to find a precipitation sampler suitable for use at the monitoring stations in Canada.

An outline of the project and some important factors in its design are discussed. Some preliminary results and their implications for precipitation chemistry sampling are presented.

THE CHEMICAL CONSTITUENTS OF CANADIAN PRECIPITATION

H. A. Wiebe

As a result of the increased interest in the role of precipitation in the cleansing of air pollutants from polluted air masses, we have begun several programs that relate to this topic. To provide information on the concentration of chemicals in precipitation in relatively pollution free areas, a network of six precipitation collection stations has been established in Canada which form part of a world wide network under the auspices of the World Meteorological Organization. Other field programs have been carried out in Canadian urban areas, and the results are compared with those obtained in Europe and the United States, where trends toward increased acid content in precipitation have been found. This increase in acidity of precipitation has been linked to air pollution in that the formation of sulfuric and nitric acids can occur when sulfur dioxide and the oxides of nitrogen are released in the atmosphere through the burning of fossil fuels.

In another field program, the accumulation of chemicals in precipitation passing through a smelter plume has been measured. While only a small fraction of the sulfur dioxide within the plume was removed, considerable amounts of water-soluble trace metals can be washed out by precipitation.

ATMOSPHERIC TURBIDITY IN CANADA

M. P. Olson

The Atmospheric Environment Service is operating a WMO Background Air Pollution Monitoring Program at several stations across Canada. Atmospheric Turbidity data and precipitation samples are gathered at each station and forwarded to the Air Quality and Inter-Environmental Research Branch for processing and analysis. The extinction of sunlight by the atmospheric aerosol is measured at a wavelength of 500 nm and 380 nm by a dual wavelength sunphotometer. These measurements are used to compute turbidity coefficients which give a measure of the quantity of scattering material in the size range 100 nm to 1000 nm and a wavelength exponent indicating the relative size distribution of the scattering particles. The turbidity values at all stations show a seasonal variation with a minimum in winter of about 0.04 and a maximum in summer of about 0.10. A continuous monitoring program is planned to establish the long term trend of atmospheric turbidity. The results from one year of operation are presented and a comparison with other published results is made.

SEASONAL AND LATITUDINAL VARIATIONS OF CF_xCl_y (FREONS) AND Cl_x (Cl , ClO , HCl) IN THE STRATOSPHERE AND THEIR IMPACT ON STRATOSPHERIC OZONE AND TEMPERATURE STRUCTURE

R. K. R. Vupputuri

It has been pointed out by Molina and Rowland (1974) that the photo-dissociation of chloro-fluoro-methanes can produce significant amounts of chlorine in the stratosphere and lead to the destruction of ozone. The main sources of freons in the atmosphere are man-made, chiefly by aerosol propellants and as refrigerants.

Using the anthropogenic sources of freons as lower boundary conditions, the seasonal and latitudinal variations of CF_2Cl_2 (freon 12), $CFCI_3$ (freon 13), Cl_x (Cl , ClO , HCl) are investigated in a radiative-photochemical-transport model which takes into account the principal interactions between O_x , HO_x , NO_x , and Cl_x photochemical systems.

The results show that the oxides of chlorine reduce the ozone concentrations substantially in the middle stratosphere with accompanying temperature changes. This would suggest that significant adverse effects may result from the continued use of freons in the lower atmosphere.

Session 11 Physical Oceanography – Part IV Ocean Turbulence and Microstructure

AN INVESTIGATION OF THE OCCURRENCE OF OCEANIC TURBULENCE, WITH RESPECT TO FINE STRUCTURE

A. E. Gargett

Data obtained from the cycling mode of a towed system operated in the North Pacific is used to investigate the relationship of small-scale turbulent mixing to the fine structure which seems to be such a common characteristic of vertical profiles of oceanic water properties. The signal from a high-frequency-response platinum-film thermometer is used, with the local mean vertical temperature gradient, to produce variables proportional to the heat flux and to an eddy diffusivity for heat. Along with measured values for the local vertical salinity and density gradients, this information is used to examine some questions of interest to the general understanding of turbulence and fine structure. First, it is shown that Woods' mechanism of oceanic mixing, that of Kelvin-Helmholtz instabilities produced on the 'sheets' associated with pre-existing fine structure by chance superposition of internal wave and mean shears, cannot be correct for the majority of mixing events in the oceanic thermocline. Evidence points to a much closer connection between turbulence and the processes which act to produce fine structure. Between 60 and 70% of the turbulence encountered in our tows is associated with "active" regions, areas where the vertical profiles of temperature and/or salinity show inversions with respect to the normal North Pacific profiles of salinity increasing and temperature decreasing with depth. The density profile in such regions is often "steppy" but invariably statically stable on vertical scales greater than about a meter, so that some basically horizontal process, such as inertial waves or density-driven interleaving, is required to produce the inversions in T and S. Whatever process is involved in forming the fine structure inversions in the "active" regions, also produces a percentage volume turbulent which is higher by a factor of 2 than that which is typical of "inactive" regions. This increased incidence of turbulence could arise either directly through increased vertical shears or else, partly indirectly, through double diffusive processes which become possible in local regions produced by the inversions. Our observations show fairly strong statistical evidence for the action of double diffusive processes in regions where the *local* vertical gradients of T and S are suitable.

OCEANIC MEASUREMENTS OF ENERGY DISSIPATION

William R. Crawford and Thomas R. Osborn

Measurements of horizontal velocity fluctuations have been used to estimate the local rate of viscous dissipation. Rates of dissipation as low as $10^{-6} \text{ cm}^2 \text{ sec}^{-3}$ have been detected. Data have been collected in local waters and the Equatorial Atlantic. Dissipation in the Atlantic Equatorial Undercurrent is concentrated in the shear layer which forms the upper boundary of the undercurrent. The average dissipation in the current is on the order of $5 \times 10^{-4} \text{ cm}^2 \text{ sec}^{-3}$.

HORIZONTAL COHERENCE OF TEMPERATURE MICROSTRUCTURE

J. A. Elliott and N. S. Oakey

Temperature gradient records from vertical lowerings of an array of four high response thermometers are used to trace microstructure features horizontally over a distance of 46 cm. Identifiable features are found to have a slope and a vertical velocity or curvature with a statistical distribution similar to that expected from an internal wave field superimposed on horizontally-layered microstructure. The horizontal extent of microstructure with a vertical scale greater than 5 cm is at least an order of magnitude greater than its vertical scale.

Session 12 Interaction of Biological, Chemical and Physical Processes — Part I

SEA COLOUR MEASUREMENTS WITH A MULTICHANNEL SPECTROMETER

R. A. Neville

A computer-controlled spectrometer has been developed for Ocean and Aquatic Affairs, Pacific Region, by a group in the Astronomy Department of UBC to be used to detect remotely the phytoplankton and silt content of water. The system consists of a 256 channel silicon diode array spectrometer which records and processes over the range of 0.37 to 1 m, at rates up to 4 per second, on computer-compatible magnetic tape. We are currently engaged in a programme to determine the most sensitive spectral signatures of the various suspended and dissolved components in sea water, and to find the limits to water colour measurements as imposed by, for example, cloud cover and wave state. The programme involves experimentation with polarizers to exclude surface-reflected light from the desired water-scattered light, and the use of a light filter and switching system to measure the incident sky light.

Data collected from flights over B. C. coastal waters will be presented to show the spectral variations caused by suspended matter and environmental effects, and demonstrate the effectiveness of the spectrometer for airborne work.

OCEAN SURFACE TEMPERATURE STRUCTURE FROM NOAA SATELLITE IMAGERY

J. F. R. Gower, D. Truax and S. Tabata

Thermal infrared data from NOAA satellites has sufficient temperature resolution to show the variations of sea surface temperature associated with coastal upwelling and tidal mixing. Photographic imagery formed from this data is usually processed to show the temperatures of cloud formations for meteorological purposes, but enhancement of the pictures has recently been demonstrated by NOAA and NASA scientists to show the smaller temperature variations of the sea surface. We have been processing taped data from NOAA satellites, to investigate various enhancement techniques, remove the grosser geometrical distortions, and reject areas where

thin clouds and haze affect the data. The final indicated temperatures will be affected by transmission through the atmosphere, but the temperature differences over areas a few miles across should be correctly indicated to an accuracy of about 0.5°K , and in some cases a single offset correction may be appropriate for a much larger area. Examples will be shown of comparisons of these indicated temperatures with conventional oceanographic data and with data from the ongoing surface temperature measuring program along line "P", the ship track between Station Papa and Victoria.

PHYTOPLANKTON PATCHES AND THE PHYSICAL WORLD

Ronald C. Wiegand

Recent studies of the spatial distribution of phytoplankton abundance in coastal environments have indicated the possible importance of physical processes in determining plankton heterogeneity. This interaction is often inferred from results of analyses of variance of both physical and biological parameters, in particular high coherence levels and similarities in shape of power spectra at larger scales.

In the interests of adding to and refining present knowledge concerning scales smaller than about 250 m, a series of observations of horizontal continuous distributions of chlorophyll *a*, temperature, salinity and oxygen was undertaken in local British Columbia waters. Data were taken at three depths, 1, 3, and 5 m in four locations and once monthly beginning in April 1973 and terminating in the following July. This period roughly coincides with the spring bloom and the beginning of its decay. Analysis of the data includes computation of coherence, phase and power spectra.

As expected the spectral results show that the low frequencies contain most of the variance. In addition, the slopes of the chlorophyll spectra on a log-log plot appear to be close to -1.66 as found in previous studies. However, coherence analysis demonstrates that a model of consistent high coherence between chlorophyll and any one physical parameter is untenable. In addition, no one physical parameter consistently shows the greatest coherence with the chlorophyll.

SPATIAL VARIABILITY OF PHYTOPLANKTON

K. Denman

Variability of measurements in the ocean has long been a problem for biological oceanographers. Recently theoretical ecologists have postulated that spatial structure is a necessary feature in so-called dissipative nonlinear systems such as the marine ecosystem, not only as a result of the interactions within the system but as a source of stability of the system itself. Results are presented here which describe characteristic spatial and temporal scales of variability in phytoplankton biomass in near shore waters. Much of the variability as measured from horizontally-towed instruments can be ascribed to sampling effects associated with the internal wave field. Because phytoplankton biomass is highly structured in the vertical, it has been necessary to study the photic layer with the Batfish, a towed porpoising body. Initial data from the Batfish are presented and biological implications of the patchiness are discussed.

Session 13 Urban Meteorology

THE URBAN BOUNDARY LAYER OVER NEW YORK CITY

R. D. Bornstein

The four dimensional distribution of wind, moisture, temperature and sulfur

dioxide in the metropolitan New York City area has been studied using data obtained from the New York University Urban Air Pollution Dynamics Project. In particular, the spatial and temporal variation of the heat, moisture and sulfur dioxide emission from all of the area and point sources has been evaluated from a detailed fuel usage survey. The effect of these emissions in modifying the climate of the NYC area has been determined, as has the effects of the urban structures. Results show that moisture and heat domes exist over the city, and that wind flow patterns are modified. Whether the flow over the city is accelerated or decelerated, or turned cyclonically or anticyclonically was found to depend on time of day, regional flow speed and flow direction. Many of the observed features of the urban boundary layer over NYC have been reproduced in the results of numerical simulations carried out using the URBMET urban boundary layer model.

A PREDICTIVE STUDY OF THE EFFECT OF ARTIFICIAL HEAT GENERATION ON URBAN CLIMATE IN HONG KONG

J. D. Kalma

Models have been developed recently by Myrup and others which simulate the energy transfer processes at the surface for specified atmospheric and substrate boundary conditions and a limited number of surface parameters. These simulators are based on the concept that it is possible to arrive at a set of meteorological parameters which satisfy the energy balance equation at the earth's surface. This approach has also been followed in successful applications to the urban atmospheric environment. Although the importance of artificial heat disposal to the atmosphere is generally realized, these recent models do not consider energy use explicitly.

This paper reports on the application of a modified version of Myrup's model, incorporating artificial heat generation at the urban surface to Hong Kong. Nineteen secondary planning units (S.P.U.'s) are considered, covering Hong Kong Island, Kowloon and one urbanized area in the New Territories. Diurnal distribution of total energy use in mid winter and mid summer in each S.P.U. has been used in this study. Twenty land use categories were identified and their relative importance in each S.P.U. determined. Surface parameters required for the model (such as albedo and surface roughness) were obtained for each land use category and were subsequently determined as weighted means for each S.P.U.

The simulation results have been analyzed both spatially and temporally. They re-emphasize the important role of urban land use in the energy transfer processes and, for the first time, clearly demonstrate that artificial heat disposal to the atmosphere is an important factor in increasing urban air temperatures throughout the day.

THE MESOSCALE EFFECTS OF NEW YORK CITY ON SYNOPTIC SCALE FRONTS

T. Loose and R. D. Bornstein

The effects of an urban area on a front are virtually unknown because of the relatively scant network of surface observing stations. Using the extensive anemometer network from the New York University urban air pollution dynamics program, frontal perturbations induced by increased roughness, and by the urban heat island, have been observed in New York City. Frontal positions were determined from hourly streamline and isotach analyses of the flow in the New York City area. The divergence in the wind field associated with the frontal zone was also estimated. In the case of a particular slow moving cold front, the front showed deceleration as it first entered the urban area from the north. After the rural portion of the front was downstream from the city, the frontal portion retarded by the city rapidly moved into the heat island of New York. The frontal configuration through a

large urban area has been found to be a function of increased boundary layer friction and increased temperature gradient induced by the urban heat island.

ON THE COUPLING BETWEEN STREET-LEVEL AND MESOSCALE BOUNDARY LAYER URBAN HEAT ISLANDS

T. R. Oke

Some results of the horizontal temperature distribution associated with the Greater Vancouver Urban Region are presented. The data are based on automobile traverses. A number of local and more general heat island features are evident. The simple heat island model for clear skies proposed by Oke (1973) is found to apply to Vancouver. The more general, and physically satisfactory advective model of Sumners (1964) is also tested using the same data. Although this model produces a reasonable relationship a number of interesting inconsistencies with theory are found. These are used to point out the need to distinguish between street-level (microscale), and above roof-level (mesoscale) heat islands. It is postulated that under certain conditions there may be quasi decoupling of the flow (and heat transfer) between these two scales. The implications for further study and modelling are discussed.

Session 14 Air Sea Interaction — Part I

STATISTICAL RELATIONSHIPS BETWEEN WIND-STRESS AND MARINE CLIMATOLOGICAL FACTORS IN THE PACIFIC SUB-ARCTIC OCEAN

W. Percy Wickett

The requirement for indices of annual changes in the marine environment of fishes has revealed several relationships between calculated wind-driven transport and oceanographic observations. Sixty percent of the variance of 300 monthly mean sea levels at Prince Rupert is associated with onshore transport and 53% of variance at Alert Bay. Forty-four percent of the monthly transport of the Oyoshio is associated with Ekman transport around the Sub-Arctic Gyre. The lag between wind-stress is 3 months off North America and 1 month off Kamchatka. Sixty-two percent of the annual variance of the area of warm water at the halocline off the B. C. coast is related to wind-stress during the previous winter combined with the removal of curl of the wind-stress during the previous year. Salinities at Station "P" and at shore stations on the Queen Charlotte Islands declined during the 1960's during a period of altered storm tracks. There was a lack of strong winter surface divergence during that period in the vicinity of the centre of the Gulf of Alaska Gyre.

WAVE ACTION IN RELATION TO WINDS AT THE PACIFIC ENVIRONMENT INSTITUTE, WEST VANCOUVER, B. C.

M. Waldichuk

To assess wave action on the foreshore of the Pacific Environment Institute, for possible future installation of a breakwater, wave records were taken on a Baylor Wave Staff at the wharf and on a Datawell Dutch Accelerometer Waverider Buoy 0.5 mi. from shore, between September 1972 and May 1974. Continuous wind records on a standard Atmospheric Environment Service 10-metre tower, mounted on the wharf, near the wave staff, were taken during the wave measurements. Original wave data sampling was at 20 minutes per hour on strip chart and magnetic tape to ensure that effects of all short-period storms were recorded. However,

analysis of data recorded during the first six months, particularly during the storms in January 1972, showed that significant wave information was obtained with 20-minute sampling every three hours, and that this was not substantially different from 20-minute sampling every hour.

Significant wave heights seldom exceeded 2.5ft (0.76m), while maximum wave heights rarely reached 4.0ft (1.2m). The highest frequency of peak periods at the wave rider was 5-6 seconds. Winds seldom exceeded 35 mph (10.5 m/s) and were usually from the southeast or southwest. Waves from the southeast are normally short in length and period, because of the relatively short fetch across English Bay. Waves from the southwest are longer and more powerful, but lose their potency as they refract into shore. The longest waves are caused by the wakes from large freighters passing by.

THE UPPER LAYER OCEAN STRUCTURE IN THE NORTH PACIFIC

M. Miyake

Seasonal changes in the upper ocean structure in the North Pacific will be discussed. The processes relevant to this seasonal variability will be discussed. The relative importance of the atmospheric turbulent transfer process and advective processes of the ocean and the atmospheric PBL, and the modulation of the radiative transfer processes and deep sea ocean circulation will be presented. The preliminary results of UBC-NORPAX program 1975 will be presented, and the plans for 1976 and 1977 will be explained as to the rationale of the experimental design.

CHEMICAL ASPECTS OF AIR-SEA INTERACTIONS: A BRIEF OVERVIEW

E. P. Jones

Chemical oceanographers concerned with air-sea interactions have been interested in gas fluxes between the air and sea, the production and nature of marine aerosols, and surface microlayer studies. A brief discussion of this work will be presented together with a description of an experiment to measure CO_2 fluxes using the eddy correlation technique.

Session 15 Interaction of Biological, Chemical and Physical Processes – Part II

PHYSICAL PROCESSES BEARING UPON THE PRODUCTIVITY IN THE ST. LAWRENCE GULF-ESTUARY SYSTEM

Paul Greisman and Grant Ingram

The large primary productivity in the Gulf of St. Lawrence system is thought to result from the upward transport of nutrients from the deep waters to the surface waters in the St. Lawrence Estuary. Several physical processes may be important: mixing of the fresher river water and the saline shelf waters which drives a much larger thermohaline circulation than the river discharge, internal waves of up to 80 m in height that can introduce deep water into the upper layers, and the effects of strong cross-channel winds. The onset of phytoplankton productivity each spring is determined by changes of stratification, turbidity, ice cover and solar radiation.

TRANSPORT OF NUTRIENTS IN THE LOWER ST. LAWRENCE ESTUARY

M. Sinclair, J. R. Brindle and M. El-Sabb

A transect across the lower St. Lawrence Estuary has been occupied on a seasonal basis, 10 out of 15 months during 1973-1974, in order to estimate the variability

in the transport of nutrients (N , P , Si) both seaward and upstream. Mass transport values through the transect are calculated for each sampling period. In addition the potential variability in the monthly mass transport that would be associated with annual differences in fresh water runoff, is estimated. This data coupled with integrated nutrient concentrations for the respective layers permits calculation of the nutrient transport for each sampling period; and also estimation of the possible range in transport associated with differences in fresh water runoff during that period. The maximum expected differences in seaward transport of nitrogen in surface waters during the biologically productive months are used to calculate the possible differences in primary production in the Gulf of St. Lawrence due to variable nutrient input associated with fresh water runoff.

PHYTOPLANKTON DISTRIBUTION IN AN ESTUARINE ENVIRONMENT WITH STRONG INTERNAL TIDES

M. Sinclair and J. P. Chanut

The importance of tidal phenomena on the distribution of phytoplankton populations, and also the problems of taking representative samples of such distributions, are considered for the Lower St. Lawrence Estuary, an environment of high amplitude surface and internal tides. Towards this aim two time series of data on parameters of importance to phytoplankton studies were undertaken at a fixed station. The first series of 12 hours duration with hourly sampling evaluates the variability in nutrients (N , P), chlorophyll a and density stratification. The second, of 45 hour duration, including measures of chlorophyll a , incident radiation and density stratification, was treated by power spectrum analysis to evaluate the contribution of the variance component of tidal frequencies to the total variance. Power spectra for chlorophyll a and σ_t are evaluated at three depths (2, 10, 40 m) and the coherence and phase relations between the tidal height data and these parameters are considered. At 10 and 40 m the chlorophyll a and σ_t fluctuations are dominated by the variance components of tidal frequencies, with strong coherence between each other and with tidal height at such frequencies. Surface distribution (2 m) of both σ_t and chlorophyll a have more complex power spectra with the tidal component masked by other processes of non-tidal frequencies. Nevertheless there is significant coherence between tidal height and both σ_t and chlorophyll a at tidal frequencies, but not between σ_t and chlorophyll a . Such variability of phytoplankton distribution gives rise to coefficients of variation up to 46% for single observations of chlorophyll a for a tidal cycle.

The temporal data is transformed into a possible spatial distribution using current data from the literature such that patch size is evaluated. Implications of the observed phytoplankton distributions are discussed.

FEEDING OF PSEUDOCALANUS MINUTUS ON LIVING AND NON-LIVING PARTICLES

S. A. Poulet

A seasonal study of carbon content of living and of carbon and nitrogen content of non-living particulate material in seawater is presented. Grazing by *Pseudocalanus minutus* on living and non-living particles has been investigated over one year. Seasonal variations in the food uptake was associated with seasonal variations of each chemical component of the particles in the water. The amount of non-living carbon constituted the major part of the food ingested, irrespective of the season. The ingested living carbon always counted for a small fraction of the copepod carbon body weight. The proportion of living carbon ingested could be equivalent to or even higher than non-living carbon at times during the late spring, summer and fall.

The concentration of both living and non-living material within each particle

peak of the spectra in the water seemed to affect the balance between non-living and living particles uptake. Non-living particles cannot be considered only as a complementary food source for small copepods. They are a basic food for *Pseudocalanus minutus* at all times. It is assumed that a consistent part of the energy needs comes from non-living particles while metabolites are provided by living particles.

Session 16 Climatic Change

THE CHANGING CLIMATE AND ITS IMPACT ON FOOD PRODUCTION

M. K. Thomas and G. A. McKay

Study of Canada's climatic history over the past century reveals a warming climate until the early 1950s followed by a general cooling trend over the past decade or two. Precipitation anomalies have been more complex, but on the Canadian prairies precipitation was relatively abundant at the turn of the century and again in the 1950s. Associated with the cooler temperature of the past decade or two, there has been abundant snowfalls during the winters of the early 1970s all across the country. The winter of 1974-75, however, has not followed the trend as temperatures have been unusually warm in parts of southern Canada, although markedly colder than normal in parts of the north and northeast. What is the impact of climatic anomalies on food production in Canada?

Taking wheat as an example, annual yields are highly variable because of the influence of drought, excessive moisture, frost and climatic conditions which are favourable for insects or diseases. The economic suitability of lands for agriculture relates to these hazards. Government planning has possibly been based on risks during a period of benevolent climate, and a reversion to climates previously experienced could severely stress food production. Technology has greatly improved productivity, but it may not be a sufficient safeguard since demands generally rise to meet available supplies. A system which enables the rapid and effective flow of crops-weather information is proposed.

RESEARCH ACTIVITIES IN CLIMATIC CHANGE

G. J. Boer and B. W. Boville

The problem of climate, climatic impact and climate change is being addressed in a variety of ways. In particular, approaches through observational diagnostic studies of Canadian climate, and through a variety of modelling techniques from the simplest one-dimensional techniques to a large-scale GCM, are being undertaken.

The activities underway will be described with particular reference to the GCM under construction and results to date will be presented.

CLIMATIC TRENDS IN THE NORTHERN HEMISPHERE

W. S. Harley and T. Jakobsson

Much publicity has been given to recent climatic aberrations. The warming trend through the first half of the 20th. century appears quite clearly in nearly all global data. The reported cooling in the last 35 years, however, is not so obvious. Grid point 1000-500 mb thickness and 500 mb height data for the 1949-1974 period are used as a hemispheric base to help resolve this question. Special attention is paid to a possible cooling trend in the Canadian climate during this period.

The results are presented in terms of monthly and seasonal variances, circulation indices, height and thickness anomaly maps, graphs of latitudinal and running means, and their significance will be discussed.

The influence of world oceans is referred to with special reference to the Eastern Pacific and its downstream effects.

FLUCTUATIONS IN THE NORMAL TEMPERATURE TREND AT SELECTED CANADIAN STATIONS

G. S. Strong and M. L. Khandekar

Spurious fluctuations in the normal mean daily temperatures for ten Canadian stations are filtered out, using weighted running means. The filtered curves reveal cycles of temperature peaks at intervals of about 17 days, including one around mid-January, vaguely referred to in various parts of the country as the 'January thaw'.

These cycles are observed to occur even in the modified climate of the Maritimes, as well as at arctic stations, and an eastward propagation of the cycle with time is noted. An attempt is made to relate these cycles to the index cycles of the atmospheric general circulation.

CLIMATIC FLUCTUATIONS IN THE FRASER RIVER DELTA - STEVESTON, BRITISH COLUMBIA 1896-1974

D. G. Schaefer

Steveston, British Columbia is located on the extreme southwestern tip of Lulu Island in the Fraser River Delta. The terrain is flat and low-lying in an area of weak horizontal gradients of temperature and precipitation. A remarkably complete set of climatological observations from Steveston stretches from 1896 through to the 1970's. A small number of months of missing data during the 1940's and the period from 1971 to 1974 were synthesized using the relationships between the long-term averages at Vancouver International Airport and those at Steveston.

Long-term fluctuations in a number of climatological elements including mean annual temperature, annual precipitation, annual snowfall, annual number of days with measureable precipitation and snowfall, annual number of days with frost, annual extreme maximum and minimum temperatures and the greatest yearly 24-hour precipitation and snowfall amounts are examined using the 10-year running mean as a smoothing filter. In some cases variations in the degree of inter-annual variability is also examined using the original data, 10-year running standard deviations or coefficients of variation. Results are displayed graphically.

With regard to mean temperature, the well-known climb from the early part of the century to the decades ending in the early 1940's is clearly defined. A subsequent drop into the cool 1950's, a rise to the mid-1960's and a final decline into the decades ending in the 1970's is evident. Mean precipitation variations appear somewhat more complex. Relatively high values at the turn of the century declined to a period of low precipitation with low inter-annual variability from about 1907 to 1926. Decades ending around 1940 and the mid-sixties were characterized by high average precipitation and low inter-annual variability. Other periods have had either low or high average precipitation with a higher inter-annual variability, when considered over 10-year periods. Long-term fluctuations in related variables such as annual snowfall, days with frost, extremes of temperature and extremes of 24-hour precipitation are compared to those of annual temperature and precipitation.

Session 17 Air Sea Interaction - Part II

VARIATION OF THE SEA SURFACE DRAG COEFFICIENT WITH WIND SPEED

S. D. Smith and E. G. Banke

There has been for many years a debate as to the amount of wind drag on the sea

surface at high wind speeds. Eddy correlation is the most direct experimental method for determining the wind drag, but very few measurements of this type have been successful at wind speeds above 12 to 16 m/s.

A thrust anemometer has been used at a sand spit on Sable Island, Nova Scotia to obtain records of wind turbulence at wind speeds from gentle breeze to strong gale force (21 m/s). While the waters surrounding Sable Island are notoriously shallow, the sea surface drag coefficients at the lower wind speeds agree with recent measurements over deep water. Combining the Sable Island results with our other measurements from the Atlantic Ocean and Lake Ontario, we obtain a regression line

$$10^3 C_{10} = 0.63 + 0.066 U_{10} \text{ (m/s)} \pm 0.23 \quad (1)$$

of the drag coefficient on wind speed. The variation of drag with wind speed is well described by the Charnock equation

$$\frac{U}{u_*} = \frac{1}{K} \ln (gz/u_*^2) + c \quad (2)$$

where the von Karman constant $K = 0.4$ and we set $c = 10.6$ to make equations (1) and (2) agree at a wind speed of 15 m/s.

THE INFLUENCE OF WIND GENERATED WAVES ON THE WIND PROFILE

Mark A. Donelan

Certain ten minute averaged wind and temperature profiles in the lowest 12 metres over Lake Ontario strikingly demonstrate the ability of wind-generated waves to return momentum to the atmosphere — direct field evidence for the so-called 'wave-driven wind.' Although the effect is most obvious when the dominant waves precede the wind, more subtle effects suggest that there is a continual appreciable interchange of momentum between waves and wind: the normalized temperature profile behaves in much the same way as it does over land, i.e. its curvature on a logarithmic height scale has the same sign as the air-water temperature difference; whereas the curvature of the wind profile is generally positive whatever the sign of the stability parameter. The explanation advanced is that longer waves, produced by nonlinear interactions among the wind generated waves, return momentum to the air stream just below the matched layer for the long waves. Thus very near to the surface the boundary layer loses momentum to the wind generated waves while higher up it gains some momentum from the longer waves, thereby increasing the curvature of the wind profile.

A STUDY OF THE PRESSURE FLUCTUATION PROFILE ABOVE WIND-GENERATED SEA WAVES

F. W. Dobson and J. A. Elliott

Measurements of pressure fluctuations in the air above various wave fields (pure swell, mixed sea and swell, pure wind-generated sea) have been examined with the intention of using them to estimate the energy transfer rate from the wind to the wave field. Both fixed-frame (Eulerian) and moving-frame (Lagrangian — from a servo-controlled wave follower) measurements were examined. Although the measurements are internally consistent, dimensionless energy transfer rates differ widely from previous "established" values.

RESONANT WAVE/WAVE INTERACTIONS ON A BEACH

A. J. Bowen

In deep water, non-linear, resonant interactions may transfer energy between

four surface waves, for example three waves may interact to produce a fourth, all four generally satisfying the dispersion relation separately. On a beach the existence of surface wave modes trapped against the shore, the edge waves, leads to the possibility of resonant interactions between three waves. This interaction, formally at second order, should lead to a much stronger resonance and it is therefore interesting that recent theories emphasise the importance of even the third-order interaction in deep water. For the shallow water interaction to be resonant in the normal sense, energy must be put into edge wave modes giving the following possible interactions:

two edge waves $\longrightarrow$ edge wave
 edge wave + incoming wave $\longrightarrow$ edge wave
 two incoming waves $\longrightarrow$ edge wave
 one incoming wave $\longrightarrow$ two edge waves

When the wave generated is not trapped (i.e. two edge waves $\longrightarrow$ leaky surface mode) energy is radiated to deep water and the wave being forced does not grow, although energy is transferred from the other modes.

For interactions between edge waves and incoming waves, approaching the beach at any angle of incidence, which are totally reflected from the beach, the initial growth rates of the various possible resonances may be determined. However, the calculations are confined to edge waves of low modal number where the shallow water solutions are most obviously appropriate. The spacial variation in the wave fields which results from the interaction makes the problem of deriving the whole time history of the interactions extremely difficult. Physically, resonant modes grow until they are losing as much energy by non-linear transfer to other modes as they are receiving; the limited laboratory evidence suggests this limit is more significant than any viscous damping.

When the incoming waves break, laboratory observations shows that at least some of the possible interactions disappear although the general flow field is apparently more non-linear. It is possible to formulate models for breaking waves and some of the implications, approximations and assumptions involved are discussed.

A NEW LOOK AT THE CLIMATOLOGICAL FREQUENCIES OF MARINE FOG

Robert J. Renard, John S. Daughenbaugh and Ronald E. Englebreton

The Department of Meteorology, Naval Postgraduate School, Monterey California, has under development a computerized program to objectively determine climatological frequencies of marine fog for all ocean areas with a consistency and completeness not heretofore available. Fog-related information in the visibility-weather group of the primary and intermediate synoptic report is utilized to specify the existence and duration of marine fog for the period represented by the observation. Data are assembled by 1×1 latitude/longitude squares and analyzed with due consideration for number of days represented by the reports.

Application, using 10-years of ocean weather station and transient-ship observations, has been made to the North Pacific Ocean area for the summer-fog season months of July, August and September. Comparisons are made to existent climatologies in the same area and the ongoing research program is described.

Session 18 Interaction of Biological, Chemical and Physical Process — Part III

THE DISTRIBUTION OF COPPER MINE TAILINGS IN TWO BRITISH COLUMBIA COASTAL INLETS: AN AGE-IMPACT COMPARISON

J. A. J. Thompson and D. W. Paton

Copper mining activities in Howe Sound and Rupert Inlet, B. C., have resulted in

extensive obliteration of the benthos in both cases. In Howe Sound, a deep open inlet, obliteration has occurred over a period of more than 70 years. The activity in the shallower, almost land-locked Rupert Inlet, spans only a 4-year period but has had a greater impact within that time period. The use of heavy metal parameters for the delineation of tailings plume boundaries and concentration-depth relationships will be discussed.

CIRCULATION PATTERN AS A FACTOR IN THE NUTRIENT SUPPLY SYSTEM IN THE GULF OF ST. LAWRENCE

Mohammed I. El-Sabh

Using all available oceanographic data in the Gulf of St. Lawrence between 1950 and 1969, a network of average stations was formed for the months of June, July, August, November and for the winter period. The dynamic method has been applied to calculate the geostrophic circulation in the Gulf during these months based on a variable reference layer. The main features of the surface circulation are the two-way flow in all entrances, the existence of both clockwise and anticlockwise gyres, the Gaspé and Cape Breton currents with which are associated the highest velocities in the Gulf. Examination of the circulation pattern as obtained in this study and the results of the International Biological Program Study in the Gulf, reveal that the cyclonic and anticyclonic gyres are responsible, at least in part, for the existence of areas with maximum primary production and high nutrient concentrations, particularly west of Anticosti Island, and the so-called "desert areas" in the north-eastern side of the Gulf.

A MODEL OF PHYTOPLANKTON DISTRIBUTION AT THE MOUTH OF THE FRASER RIVER

B. D. de Lange Boom, P. H. LeBlond and T. R. Parsons

A semi-annular maximum has been observed during the summer around the mouth of the Fraser River. In order to elucidate the relative roles of the many mechanisms and influences governing phytoplankton density and leading to the observed distribution, we have constructed a theoretical model which includes biological as well as hydrodynamic effects. Assuming a given steady velocity profile and commonly used parameterizations relevant to phytoplankton growth and decay, the plankton density in the upper layer was integrated numerically along streamlines. The relevance of the various parameters is examined through their effect on the calculated distribution patterns.

Session 19 Air Pollution Meteorology – Part II, Urban and Regional

SUSPENDED PARTICULATE CONCENTRATIONS: SPATIAL CORRELATIONS IN THE DETROIT-WINDSOR AREA

R. E. Munn

During a 14-month period in 1967-68, 24-hr suspended particulate concentrations were measured every third day at 56 stations in the Windsor-Detroit, Sarnia-Port Huron region. In this paper, spatial correlation coefficients have been computed, and isopleths have been plotted.

Using the entire data set, these correlations are rather low. By dividing the data into subsets each with similar wind direction patterns, however, the correlation coefficients are increased, and some interesting patterns emerge. It is concluded that on individual days, the particulate levels measured at a single site are not useful

indicators of urban particulate loadings unless the meteorological situation is specified. Some implications for optimizing the density of air pollution networks are discussed.

AN APPLICATION OF A SIMPLE ADVECTIVE POLLUTION MODEL TO THE CITY OF CALGARY

D. M. Leahey and M. J. E. Davies

The Department of the Environment of the Province of Alberta is funding a research effort to develop air quality models for the cities of Edmonton and Calgary with the purpose of predicting ground-level concentrations of NO_x , CO , and water vapour as a function of meteorological variables.

This paper describes that part of the study which involves the application of a simple advective model to the city of Calgary. The model was used to predict CO concentrations observed at the John J. Bowlen building in downtown Calgary, from a knowledge of the NO_x concentrations observed at this site. The correlation coefficient between 560 predicted and observed values of CO concentrations was found to be in excess of 0.80.

PRELIMINARY RESULTS ON THE VERTICAL TEMPERATURE STRUCTURE OF THE VANCOUVER AREA

P. W. Suckling, D. K. G. Love, W. F. Tanner and R. E. Hardy

Vertical temperature profiles using shielded aspirated thermistors were obtained over the Vancouver area from a car traversing the Mount Seymour road, an airplane flown over the Burnaby refinery district and the Grouse Mountain gondola. The three methods compared favourably. Data from the car profiles for days in October, 1974 indicated that the atmosphere is stable at different times of the day and for cloudless and overcast sky conditions. This stable layer was several hundred meters thick.

ON THE STRAIT OF CANSO FIELD STUDY

F. H. Fanaki

Due to the accelerated industrial development in the Strait of Canso area, EPS requested that the Air Quality Research Branch of AES conduct an air pollution study of the area.

The main object of the study was to obtain information on the variation of the local meteorological conditions and their effect on the dispersion of pollutants from the existing sources at Point Tupper. The data collected will be also used to verify mathematical and physical models of the Strait of Canso developed at AES.

Measurements of wind and temperature profiles were made during the period July 26 to August 2, 1974. Two mobile stations, separated by several kilometers, were operated during this period, releasing balloon-borne minisondes simultaneously. The locations of the stations were determined by the wind direction. One station was located in the industrial area of Point Tupper and the second was downwind from these sources.

In conjunction with these measurements the rise and the vertical thickness of two plumes from a paper mill and a power generating station were determined via photography. The data will be used to determine the plume rise at Point Tupper, these data were supplemented by turbulence measurements from a bivane located at Point Tupper. Surface temperatures were measured along the length of the strait several times a day.

An 8 foot diameter physical model of the region has been built. Instrumentation

is being developed to simulate the pollutant sources and to measure a chemical tracer emitted from the sources. Numerical modelling is at a very fundamental stage of describing turbulence characteristics and mean wind fields.

The following preliminary paper describes in some detail the measurement procedures and is illustrated with a sample of the data collected. Some of the data has been analysed and will be discussed.

Session 20 Dynamic Meteorology — Part II, General

ACOUSTIC GRAVITY WAVE EMISSION FROM SEVERE CONVECTIVE STORMS

J. E. Donegani and W. R. Peltier

Simple models are constructed to examine acoustic gravity wave emission by latent heat release in regions of severe convective activity. Both isolated centres and "squall lines" of cumulus convection are considered. The wave packet launched by transient heating propagates away from its source at a rate given by the appropriate group velocity. This wave packet can "trigger" an area of potential instability by imposing a vertical velocity regime in a moist environment of sufficient intensity to inaugurate the release of latent heat. This "wave-CISK" process results in the creation of organized bands of cumulus activity with a wavelength between them determined by the dominant wavelength in the generating wave packet. This secondary storm "front" can occur several hundred kilometres distant from the original source location. A documented synoptic occurrence is discussed and satellite photographs of the cloud field reveal a wavelength of the band structure which is in accord with the prediction of theory. Higher frequency emission from such severe storm systems is also considered and theory compared with surface observations.

A STUDY ON LEE CYCLOGENESIS AND BEHAVIOUR OF UPPER AIRFLOWS IN LARGE-SCALE MOUNTAINS

Y-S. Chung

A previous study on cyclogenesis in the lee of the Canadian Rockies and the East Asian Mountains is extended to the Andes. Results similar to those of the previous study are again found. Both studies lend support to general circulation models which identify the effect of a barrier on the initiation of lee cyclones. A barrier effect of a large-scale mountain is observed to be of prime importance to lee cyclogenesis.

An additional finding of this study is that the 500-mb windflows over the massifs tended to be weaker than those observed downstream, which is not what one would expect from many physical models. This is mainly due to the effects of orographic vertical motions, horizontal divergence and deflection, vertical shrinking, blocking and splitting of flows in the mountains.

A DETAILED CASE ANALYSIS OF THE ALBERTA CHINOOK

P. F. Lester

The chinook of southern Alberta has been described as one of the most important wintertime meteorological phenomena of the area. Past research efforts have been devoted primarily to climatological and synoptic aspects and to the effects of the Chinook. Because of the sparsity of data, investigations into the mesoscale structure and behavior of the phenomenon have been limited. Recently, a chinook research project was initiated at the University of Calgary with a major objective being the isolation of the mesoscale characteristics of the Chinook. In the present paper, the

results of a detailed analysis of one case are presented. Conventional synoptic meteorological data are combined with high resolution satellite data and surface temperature information from a dense array of climatological stations to illuminate mesoscale temporal and spatial variations of a chinook occurrence. It is demonstrated that extensive information about mesoscale features can be derived from the analysis of available data, that is, without special and expensive observational methods. Pertinent results from other case studies are presented and areas of needed study are outlined.

THE FATA MORGANA AND THE FATA BROMOSA

A. B. Fraser and W. H. Mach

Known by many names throughout the world, the Fata Morgana undoubtedly ranks as the most fantastic of all the mirages. Stories are told of castles, cities, walls, and even forests appearing out of nowhere, lasting a short time and then vanishing into oblivion. Explanations of the phenomenon have always been cursory while explanations of the related phenomenon, the Fata Bromosa or Fairy Fog, have been nonexistent. The meteorological conditions under which the Fata Morgana and the Fata Bromosa occur will be discussed and it will be shown how they both arise by different aspects of the astigmatic nature of the atmospheric lens. The significance of these astigmatisms will be discussed both in terms of the visibility through the atmosphere and the effect they have on the optical inversion of lapse rate.

Session 21 Estuarine Processes, Physical and Chemical — Part I

ANNUAL AND LONGER TERM VARIATIONS OF DEEP WATER PROPERTIES IN THE COASTAL WATERS OF SOUTHERN BRITISH COLUMBIA

G. L. Pickard

Observations of deep water properties (temperature, salinity, dissolved oxygen and the derived values of density) have been assembled from the Data Reports of the Institute of Oceanography of the University of British Columbia and are presented to show the characteristics of the annual variations at eighteen locations in the coastal waters of southern British Columbia. Long-term variations (for eight years or more) are presented for eight of the locations. Variations of one year period are evident to 100 m depth at all locations and to 300 m or more at many of them. The variations are of different forms, sinusoidal, peaked or saw-tooth, and there are some differences in phase between the property variations at different locations. Long-term variations (over several years) of annual mean values are small and decrease with increase of depth. Much of the evidence suggests that the changes below 100 m depth are due to longitudinal advection (flow) from elsewhere rather than to vertical transfers from the sea surface in the immediate locality.

THE HEAT BUDGET STUDY OF PENDRELL SOUND

W. R. Buckingham, D. Farmer and M. Miyake

A field program of heat budget study was carried out in Pendrell Sound during summer of 1974 by the Dept. of the Environment in an attempt to resolve the mechanism involved in creating the warm water favourable to oyster spawning in this inlet. The temperature — salinity structure was measured at various locations along the channel and meteorological parameters relevant to heat exchange were observed. The relative importance of local heating and advection will be assessed.

W. H. Bell

The current-metering program in Howe Sound is described and some data reported. These include time series for current speed and direction, salinity and temperature. The variability of currents in the upper layer is noted, including periods of several days of persistent flow (at some depths) toward the head of the Sound and periods when the current direction appears to be highly variable. The salinity data is examined for indications of the influx of high density water over the sill.

SURFACE WATER MOVEMENT IN A FJORD, HOWE SOUND, BRITISH COLUMBIA

Joseph R. Buckley

Experiments have been done in the past two years to trace water movement in Howe Sound, a highly stratified fjord. One of these involved radar tracking of drogues in the surface layer. Enough drogues were used to allow, in general, a valid transformation from a Lagrangian to an Eulerian description of the flow field. The photographic record of this experiment was digitized for computer analysis. Time-lapse movies of the drogue tracks were made with the aid of a computer to examine the variability of the flow field. Much more spatial variability was found than is commonly assumed in a fjord.

Forcing functions of wind, tides and river runoff were examined to find their effect on the flow. Wind forcing was dominant over the entire fjord, but river flow also proved to be important as a major source of lateral inhomogeneities. Tidal effects seemed small.

These results will be discussed and movies will be shown.

Session 22 Forest and Agricultural Meteorology

ON THE TRANSITION FROM WATER TO AIR IN MICROMETEOROLOGICAL MODELLING

P. H. Schuepp, K. D. White and V. V. Tran

The complexity of two- and three-dimensional micrometeorological flow fields (e.g. in and around crops, greenhouses, windbreaks etc.) precludes the use of numerical modelling for the estimate of energy and mass fluxes, leaving field experiments and physical modelling as operational techniques. The flexibility and controlled variation of parameters provided by the latter must be weighed against lack of realism, and if water is used as the modelling fluid the difference in molecular properties presents an additional difficulty in extrapolating results. These problems are discussed in two examples:

- a) the flow dynamics, energy and mass transfer of inclined plates (from leaves to greenhouse roofs) where there is good quantitative agreement between air and water for relatively low Reynolds numbers and where the data for high Reynolds numbers are presently being examined;
- b) the flow dynamics, energy and mass transfer in crops where model experiments indicate that the proportionality constant between eddy diffusivity 'near a surface' and the transfer to that surface may be relatively independent of the fluid, making it a promising parameter for extrapolation of results from one system to another.

Stomatal opening of microwave irradiated leaves were studied as a function of leaf temperature, air temperature, and wind velocity inside a closed-circuit wind tunnel. Leaf temperatures of bean leaves were found to drop 2 to 4 °C under constant energy input, zero wind velocity, and an air temperature regime of 30 to 45°C.

A field application of radiant microwave energy to induce artificial blossoming and maturity of an encaged apple tree in spring is also described. A horn antenna was used to radiate 1.2 kW at a frequency of 2450 MHz. Air, leaf and apple temperature distribution within the tree indicated maximum utilization of energy by the system. At 90 cm from the antenna, for example, the temperature difference between apple and air was 20°C.

Chemical analysis to determine the total acidity and the total reducing sugar of the apples was carried out after 80 hours of accumulated radiation. An increase of sugar content was found for apples which were exposed to 20 mw/cm² or more radiation intensity.

FACTORS AFFECTING THE SURFACE RESISTANCE OF A FOREST CANOPY
T. A. Black and C. S. Tan

In order for Monteith's micrometeorological model of evaporation to be applied to forests, a reliable method of determining the surface resistance of the forest canopy must be obtained. The physiological nature of the surface resistance was studied by comparing the stomatal and surface resistances of a 11-m high Douglas-fir forest. Stomatal resistance of the needles was measured using porometry, while the surface resistance was calculated using energy balance measurements of evaporation. The typical steady increase in the forest surface resistance during daytime hours, even at high soil water matric potentials, was observed. A similar trend in the stomatal resistance indicated that increasing surface resistance during the daytime was caused by gradually closing stomata. Average daytime values of stomatal and surface resistance were also observed to increase together during a dry period when soil water matric potentials declined from 0 to -9 bar. Values of surface resistance calculated from stomatal resistance measurements and a leaf area index estimate agreed well with calculated values of surface resistance. The dependence of stomatal resistance on light, vapour pressure deficit, twig and soil water potentials are summarized.

EDDY CORRELATION AND FLUXATRON ESTIMATES OF SENSIBLE HEAT FLUX OF A DOUGLAS-FIR CANOPY

H. R. Holbo, L. J. Fritschen and M. O. Smith

Sensible heat flux estimates were derived in three independent ways from high frequency measurements of vertical windspeed and temperature above a Douglas-fir canopy. One way involved a specially developed fluxatron circuit processing Gill-type propeller and thermistor measurements to yield a real-time estimate of sensible heat flux. This was later compared with two conventionally computed estimates using basic eddy correlation data taken with another propeller-thermistor combination and with a sonic anemometer-thermometer. All three were then compared with flux estimates obtained from mean profile (aerodynamic and Bowen ratio) and lysimetric measurements. Errors due to inadequate high frequency response of the sensors were evaluated by spectral analysis. Differences in the flux estimates due to running means versus exponential averaging were examined. Overall, the results are favorable toward the eddy correlation approach to flux estimation.

over forests and to the application of the fluxatron to perform the estimation.' The fluxatron's capability at processing two channels of high frequency data yet producing one channel of low frequency output reduces not only data acquisition requirements but computational requirements as well. The major advantages of the fluxatron are in providing for increased sampling intensities and in more opportunities for comparative studies with standard recording equipment.

AGRICULTURAL CLIMATE OF THE SASKATOON AREA D. A. Bernachi

Several Meteorological parameters are examined using Saskatoon climatic data from 1900 to 1974. Relationships are established between these parameters and spring wheat yields. Of the heat related parameters — mean temperature, growing degree-days and frost-free season — only the frost-free period appears to be critical. Good correlations were found between wheat yield rates and annual rainfall or annual total precipitation.

Session 23 Hail

ON THE CALIBRATION OF HAILPADS E. P. Lozowski and G. S. Strong

Hailpads consisting of one-foot-square pieces of styrofoam, about one inch thick and covered with aluminum foil have been used in conjunction with hail experiments in many countries. Because of their low cost, they can be used by the hundreds to detect the occurrence of hail over large areas such as that of the Alberta Hail Project ($\sim 20,000 \text{ mi}^2$). In addition, because they preserve the dent made by hailstones impacting on them, they can be used, when properly calibrated, to determine the size distribution of the hailfall.

A simple dynamical model of the collision process has been developed, which predicts (i) that the dent volume is proportional to the kinetic energy at impact of the hailstone and (ii) that a power law relation exists between dent diameter and hailstone diameter. These two predictions are well-confirmed by a laboratory calibration using spheres made of steel, glass, and ice. However, attempts at field calibration of the hailpads with real hailstones under natural storm conditions, are not entirely in agreement with the laboratory results. We consider reasons for this discrepancy and suggest means for making the most effective use of the calibrations.

OPERATIONAL CLOUD SEEDING AND RESEARCH ACTIVITIES IN SUPPORT OF THE ALBERTA HAIL PROJECT K. L. Grandia

The 1974 Alberta Hail Project marked the first of a five-year operational cloud seeding program designed to evaluate the effectiveness of airborne seeding for hail suppression. A total of seven aircraft and crews, and two ground radar controllers, provided the teamwork for the program. Two modes of *AgI* injection were utilized, cloud base seeding with end-burning flares, and cloud top seeding with ejectable pyrotechnics.

One of the seeding aircraft was instrumented for meteorological measurements, and provided a platform for several research endeavours in support of the operational program. One such study was an evaluation of ground based generators for cloud seeding. A surfaced based fluorescent particle generator was operated in conjunction with an airborne real-time sampler to detect and count the intercepted particles.

The resultant plume profiles were numerically modelled to simulate the plume characteristics under a variety of stability situations.

This paper will discuss the development of the airborne system and describe the various research activities.

FIELD MEASUREMENTS OF HAILSTONE AERODYNAMICS

E. P. Lozowski and A. G. Beattie

In attempting to study hailstone aerodynamics either experimentally or theoretically, several approximations are frequently made. First, a regular shape such as a sphere or spheroid may be assumed. Then a real or conceptual model may be constructed of a substance other than ice, or of ice with a different density distribution to that within a hailstone. Finally, the model may be constrained to have fewer degrees of freedom than it would in free fall, or it may be allowed to fall freely, but in water or in air under different conditions than those which could prevail in nature. In order to avoid making any of these approximations, the authors have sought out hailshafts and photographed natural hailstones under free-fall conditions near the ground. This paper describes:

- (i) the techniques used to intercept and photograph hail using a stereo camera pair and stroboscopic illumination,
- (ii) the mathematical methods used to derive accurate velocities from a pair of stereo photographs subject to variable and unknown errors,
- (iii) the results of the measurements including the relation of fallspeed to size and shape, and inferences about hailstone tumbling.

AN AXISYMMETRIC HAILSTORM MODEL

M. English

A numerical model that describes the evolution of an axisymmetric convective cloud in a stratified environment is presented. The model consists of equations governing the conservation of mass, vorticity and entropy, which are time - integrated in a radial plane at 41×41 grid points. Microphysical calculations are carried out at the innermost 15×41 grid points and cover condensation, evaporation, drop freezing, melting, stochastic drop collection and drop breakup.

The model has been applied to a severe hailstorm that occurred in Alberta. Preliminary results suggest that the model is capable of reproducing at least some of the radar - observed characteristics of the storm.

Session 24 Estuarine Processes Physical and Chemical - Part II

ORGANIC CARBON IN THE ST. LAWRENCE ESTUARY

M. Khalil

The total organic carbon (TOC) in the water column in the St. Lawrence estuary varies between 1 and 9 ppm. The determinations of the organic and inorganic carbon were performed on a Beckman total organic carbon analyzer, model 915. The sensitivity and limitations of the method and its adaptability to estuarine water together with the filtration procedures will be discussed.

The TOC is inversely proportional to salinity. TOC increases with depth to attain a maximum in the intermediate layer and then drops to a minimum in the deep layers.

Ten stations were chosen to represent the water masses entering the estuary namely the St. Lawrence river, the Saguenay and the deep ocean water together with the outcoming waters which later will form the Gaspé current. TOC and total inorganic carbon (TIC) were determined at five different depths on a monthly basis from May to November.

CHARACTERISTICS OF A MESOSCALE FRONT IN THE ST. LAWRENCE ESTUARY

R. Grant Ingram

Characteristics of a quasi-steady mesoscale front, over the Ile Rouge bank, in the St. Lawrence estuary are discussed. It is shown that an advancing front, having both a large density gradient and a convergent surface flow, is generated for each lunar semi-diurnal tidal cycle. Frontal advance occurs just after high tide. The retreating front exhibits an irregular density boundary and no convergence. Bottom topography and cross-channel tidal differences are thought to be the dominant factors in controlling frontal excursions.

THE NATURE AND SIGNIFICANCE OF INTERNAL TIDES IN THE ST. LAWRENCE ESTUARY

W. D. Forrester

An internal tide of semidiurnal period is shown to propagate seaward along the axis of the St. Lawrence Estuary with associated cross-channel oscillation typical of a Poincaré-type wave. Its generation is argued to be due to the interaction of the surface tide with the sloping bottom topography at the inland end of the Laurentian Channel. The character of the near-surface tidal streams is shown to be more strongly influenced by the internal tide than by the surface tide in much of the region, with important implications for navigation. Large amplitude vertical oscillation of isopycnals at the tidal period is associated with the internal tides, particularly near the generation area. This provides a possible mechanism for mixing nutrients from below up into the euphotic zone.

SUB-SURFACE CURRENTS IN THE STRAIT OF GEORGIA, WEST OF STURGEON BANK

Phillip Y. K. Chang

Long time-series of currents at six locations are analyzed. The longest continuous record spans 519 days. An examination of their vector power spectra shows that the low-frequency non-tidal energy in the range 0-1/4 cycles/day, and the tidal energy together account for 85% of the total energy. Typically, the energy is equally divided between the low-frequency currents and the tidal currents.

The low-frequency currents, measured at locations separated horizontally by 10 km, is low. This low coherence is also observed between the low-frequency currents separated vertically by 90 m. In this same low-frequency range, there is significant energy in the records of local sea level and air pressure.

The semi-diurnal tidal energy is 1 - 2 times that of the diurnal tidal energy. The tidal current ellipses are obtained by a harmonic analysis. It is found that the shape and rotational sense of these ellipses vary with time. The M_2 amplitude can vary with time from 6 to 11 cm/s at one of the locations. The constituent amplitudes are observed to vary both horizontally and vertically from location to location.

THE ANALYSIS OF HAILSWATHS BY INFRA-RED RADIOMETRY

K. Markey and G. Goyer

A new method of analysis and display of airborne infrared radiometer data is presented. The method involves recording, enhancing, digitizing, filtering, compressing, calibrating and displaying on contour radiation temperature maps, the ground temperatures measured with a Texas Instrument RS-310 scanning radiometer and a Barnes PRT-6 staring radiometer.

The new method is applied to the analysis of a hailswath near Fort Morgan, Colorado, on 13 June 1972.

Final conclusions on the research and operational uses of this technique for the analysis of hailswath are presented.

ON THE ANALYSIS OF SCANNING RADIOMETER IMAGERY IN THE ARCTIC WINTER

E. R. Reinelt

Knowledge of the distribution of cloud in winter over the Canadian Arctic Archipelago and the Beaufort Sea is very sketchy because of the long period of darkness. Over most areas, the only data available for nephanalysis are provided by scanning radiometer infra-red (SRIR) imagery. The analysis may be supplemented on occasion by scanning radiometer visible imagery when lighting conditions are adequate, e.g., during periods of arctic twilight. However, in the depth of arctic winter only the SRIR imagery provides useful, though often ambiguous information.

The analysis of low cloud in the Arctic is complicated by the fact that the difference in temperature between the ice pack and the tops of low cloud is usually small. Frequently, the lower layers of the airmass overlying the Arctic Basin may be isothermal, or a deep and extensive inversion layer may be present. Under isothermal conditions, the image contrast between cloud top and surface ice is effectively zero, while under inversion conditions the cloud tops will appear darker than the underlying surface. However, since two or more successive satellite passes usually provide broadly-overlapping images of a given area north of the Arctic Circle, analysis of the changing shape of images may sometimes be used to resolve ambiguities, and discriminate between cloud and surface features at similar temperatures.

HOW TO TAKE AN ATMOSPHERIC TEMPERATURE SOUNDING TO A HEIGHT OF FIVE KILOMETERS BY WATCHING THE SETTING SUN

A. B. Fraser and R. Hemler

The equations that enabled an optical inversion of lapse rate to be performed were presented at the 7th Congress and the applicability of the theory to the determination of micrometeorological scale temperature profiles was presented at the 8th Congress. It is now shown that for soundings up to a height of about 500 mb, accuracy comparable to that of a radiosonde can be expected from the inversion of measurements of the image of the setting or rising sun.

THE QUADRA WEATHER RADAR SYSTEM

E. Ballantyne and G. Austin

The weather radar system used for recording both on magnetic tape and photo-

graphically on the ship Quadra is described. This system, including the equipment allowing real-time production and transmission of a quasi-horizontal slice and height information will remain on the Quadra for at least preliminary experiments to be made at Station Papa.

Session 26 Dynamic Meteorology — Part III, Models

A TWO-DIMENSIONAL GENERAL CIRCULATION MODEL OF THE ATMOSPHERE INCORPORATING DIABATIC EFFECTS AND SURFACE FRICTION

S. F. Woronko, N. MacFarlane and R. K. R. Vupputuri

A two-dimensional general circulation model of the atmosphere is being developed using conservation equations of momentum, mass and energy in conjunction with hydrostatic and thermal wind balance and taking into account external influences such as long and short wave radiation, latent heat and surface friction. Two methods are being experimented with to treat the eddy forcing functions resulting from the zonal average. In the first method, the large scale eddy transport quantities are parameterized by specifying explicitly the diffusion coefficients (K_{yy} , K_{yz} , K_{zz}) based on observations. The second method involves solving the baroclinic instability problem every few time steps and relating the eddy diffusion coefficients to the dependent variables. The preliminary results of integration will be presented. The applications of the method to the studies concerning the natural causes of climate and the potential impact of man's activities in the atmosphere will be discussed briefly.

BAROCLINICALLY UNSTABLE EIGENMODES OF A TWO-LEVEL SPHERICAL ATMOSPHERIC MODEL

H. Warn

The equations of motion for two layers of inviscid immiscible constant-density fluids in stable stratification on a rotating gravitating sphere are linearized about a state of geostrophically balanced zonal motion in the upper layer which is allowed to vary in latitude. Approximate eigenfunctions are obtained using a Galerkin procedure, and particular emphasis is placed on the baroclinically unstable modes obtained with various layer depths, density stratification and wind profiles. The results were compared with the predictions of the 2-layer mid-latitude β -plane model of Phillips (1953) and Pedlosky (1964), with a constant zonal wind in the upper layer. In all the experiments performed, the most unstable wave occurred at a much smaller east - west wave number and had a much smaller growth rate than the most unstable mode of the corresponding 2-layer β -plane model.

MODELLING OF STANDING WAVES WITH NON-LINEAR EFFECTS

J. Spagnol

Planetary scale stationary disturbances in the winter stratosphere are investigated by means of a quasi-geostrophic model. The steady state distribution of small amplitude perturbations superimposed on a zonal wind distribution are computed. A realistic parameterization of infrared cooling showed that radiational effects are a major sink of perturbation wave energy in the upper atmosphere. The effect of the artificial upper and equatorial boundary conditions was investigated and found to be significant for the correct modelling of these waves. The non-linear interactions of the stationary waves was found to have an important effect on the wave structure. The resultant computed wave structure reproduced almost all the major features found in the corresponding observed state.

It is considered that the added steps taken in the modelling of the stationary long waves constitute an improvement over all known linear studies. The primary conclusion is that models designed to study the stationary ultra-long waves in the stratosphere must include the interactions among these waves if they are to reproduce their structure adequately.

TREATISE OF THE HYBRID MODE OF A DIFFUSE AND SPECULAR REFLECTOR ON COMPUTING THE EMERGENT RADIATION BY USING THE 'ADDING' METHOD

T. Takashima, C. I. Taggart and E. G. Morrissey

The method of computing the diffuse reflection and transmission of radiation from an inhomogeneous, plane-parallel, planetary atmosphere bounded by the hybrid surface of a diffuse and specular reflector by using the "adding" method is discussed. If the atmosphere is simulated by a number of homogeneous sublayers, the radiation diffusely reflected and transmitted by the atmosphere can be expressed in terms of the diffuse reflection and transmission matrices of radiation of sublayers. With this method, the troublesome treatment due to the polarity effect of radiation is overcome. It is demonstrated in this paper that the "adding" method can be extended to the treatment of the hybrid mode of a diffuse and specular reflector on computing the emergent radiation. It is found that this surface mode is also simple in expression and hence suitable for numerical computation in a realistic model atmosphere-ground system. It can be applied to problems of hydrological information such as for ice-and snow-covered areas as well as to assess the growing state of vegetation by the use of remote sensing data from earth satellites employing high resolution radiometers.

Session 27 Dynamics of Inshore and Inland Waters — Part I

LONG-TERM CIRCULATION IN SHALLOW SEAS

G. T. Csanady

Shallow bodies of water are known to respond rapidly to wind stress. Along the eastern seaboard of North America, for example, storms produce longshore flow of substantial amplitude. Another component of the flow is density driven, mainly owing to freshwater influx at the shore. According to steady-state theory (due to Stommel and Leetmaa) the mean wind stress — which drives the water northeastward — should dominate. The experimental evidence shows the water drifting southwestward, in which direction the density contrasts would drive it.

The resolution of this seeming paradox is attempted in terms of an intermittent wind stress conceptual model. Careful averaging of the equations of motion shows that high Reynolds stresses within the body of the fluid during alternating northeast-southwest storms may be sustained without resulting in a high average velocity in the direction of the average wind stress (in a way, these Reynolds stresses "short circuit" the momentum input by the wind directly to the bottom). By contrast, pressure gradients due to density contrasts average linearly and their cumulative effect is relatively more substantial. Thus the *sustained* action of this weaker force overcomes the average of the much stronger intermittent storm effects.

Similar phenomena occur in the Great Lakes in early summer, the density contrast being due to the rapid temperature rise of shallow, nearshore waters. The long-term circulation tends to become a cyclonic gyre, in place of the double wind driven gyres one would predict as a steady state response to the average wind.

Short term periodicities in water motions occurring in the nearshore zone of the Great Lakes have been interpreted by a number of investigators as edge waves traveling along the coastline. A statistical search for edge waves was undertaken for twelve episodes of intense nearshore activity utilizing water level and current meter data collected during the International Field Year on the Great Lakes in Lake Ontario. An unexpected finding is that the majority of high frequency oscillations are associated with transverse gravitational seiches of complex nodality. For the remaining events, the phase and amplitude relations are in reasonable agreement with those predicted from a numerical model of shallow water edge waves. In particular, in five of the seven cases where the direction of passage of a storm center could be determined from surface barometric records the direction of phase propagation of the edge waves along the shoreline coincided with the direction of travel of the atmospheric disturbance.

Session 28 Air Pollution Meteorology – Part III, Local Dispersion

ON THE DISTURBANCE OF THE ATMOSPHERIC ELECTRIC FIELD CAUSED BY AN ISOLATED POINT SOURCE

S. R. Shewchuck

It is known that a wide variety of industrial plumes emit not only particulate aerosols into the environment, but also significant amounts of space charge as well. The possibility of utilizing this charge to study particulate dispersion has not been adequately investigated. The technique involves using the atmospheric electric field anomaly, introduced by the space charge, to infer a spatial distribution aloft.

Complex field effects generated by multiple sources in the more heavily industrialized regions have made this type of research quite difficult. Since the potash industry is well isolated, several trials have been undertaken to test the feasibility of this type of work in Saskatchewan. Field sensing equipment was located at 150 meters and one kilometer downwind of a stack. Electric fields at the earth's surface have been shown to be altered by approximately an order of magnitude from the background values. The main core of the plume appears to consist of particles that are negatively charged. Effects of charge neutralization, ion sheath formation and dispersion result in a decrease in peak values of 60% at one kilometer. It is estimated that the technique may accurately trace the plume at least five kilometers from the source.

This study will not only allow a remote tracking capability of a particulate plume, but also will lead to increased knowledge on the turbulent diffusion properties of the atmosphere for particulates.

The difficult problem of ion transfer and the extent to which the charge cloud represents the chemical species are problems which must be tackled to gain the total picture of the electrified particulate aerosols within the environment.

DISPERSION OF AgI IN A MOUNTAIN VALLEY

J. D. Reid

Air pollution and weather modification interests share a common concern with respect to dispersion in mountainous terrain. Environmental authorities are concerned with the restricted dispersion from industrial and domestic sources in mountain valleys, which commonly leads to excessive air pollution levels. Weather modi-

fiers are interested in optimizing the demonstrated precipitation increases produced by the dispersion of silver iodide from a ground based seeding generator to a cold orographic cloud.

During the winters of 1973-74 and 74-75 observations of dispersion of highly detectable *AgI* tracer were conducted in a mountain valley near Climax, Colorado, using a highly instrumented meteorological research aircraft. *AgI* "smoke" was produced by a ground-based cloud-seeding generator. Situations with moderate to strong 500 mb up-valley flow were investigated. A digest of several cases will be presented. The data indicate that even for strong upper level flow the dispersion is highly influenced by the diabatic mountain-valley airflow.

FATE OF SO_2 IN THE ATMOSPHERE FROM SOUR GAS PLANTS

R. D. Rowe

An outline is given in this paper of the objectives and research plans for one of the eight projects recently supported by a five year National Research Council Negotiated Development Grant to The University of Calgary Interdisciplinary Sulphur Research Group (known as UNISUL). The academic staff involved in the original application for this project are: K. Aziz, G. Hodgson, H. Krouse, M. Mohtadi, and R. Rowe. Also, already affiliated with this project are: R. Klemm (Alberta Research), A. Legge and P. Lester (U. of Calgary), and M. Nyborg (U. of Alberta).

The principle aim of this project is to produce a mass balance for the sulphur that is emitted into the atmosphere from sour gas plants in various localities in Alberta. A meso-scale sulphur budget for the group of sour gas plants near to Calgary is being investigated. The plume rise and dispersion for one of the plants in this area has been investigated in detail. A preliminary budget will be presented for some summer months during 1973 and 1974.

The effluent from a sour gas plant sulphur recovery unit can be considered to be relatively "clean" in the sense that the only pollutant emitted is SO_2 without a significant loading of particulates or other contaminants. This effluent is markedly different from that emitted from a coal-burning power plant, a smelter or an oil sands coke-burning power plant, and may have a greater potential to acidify soils and water, because there appears to be less opportunity to form neutral sulphates. For these reasons, sour gas plant plumes deserve detailed attention.

In order to test various models of the dispersion and chemical transformation of SO_2 from sour gas plants, plume tracing experiments will be conducted this summer (1975) using SF_6 for long time averages (one week), and sulphur isotope ratios and other techniques for short time averages (minutes). An attempt will also be made to determine the "background" concentrations of sulphur species and particulates.

DOWNWIND DRIFT, DEPOSITION AND HAZARD ESTIMATION FROM GROUND SPRAY APPLICATION OF HERBICIDES

J. Maybank, K. Yoshida and R. Grover

A series of field trials was carried out in 1973 and 1974 wherein a single swath was sprayed with 2, 4-D amine containing a dye tracer. Samplers downwind of the swath at three distances permitted the dosage and mass of droplet drift to be determined as well as the droplet size spectra. This drift as a fraction of amount applied was found for several combinations of nozzle type and application rate over a range of wind speeds.

In addition, the decay rate of the airborne cloud with distance downwind could be found from the successive sampling lines, and this decay compared with fall-out as measured from sampler dishes placed on the ground. The reduction curve was

then used to estimate the total off-field drift that might be expected from routine crop spraying under various conditions, and to establish the over-all deposit and airborne drift budget.

From the entire trial series it could be shown which spray nozzle provided the least off-target drift and under which conditions this drift reduction was likely to be significant. It was also possible to compare downwind ground deposition hazards with those that might affect crop and foliage material through impaction from the airborne cloud. This last was found to be the more significant of the two, even when only 2-4% of the sprayed material drifted off-target.

Session 29 GATE

SPATIAL VARIABILITY IN THE TROPICAL MARINE BOUNDARY LAYER

D. S. Davison and R. E. Mickle

During the GARP Atlantic Tropical Experiment (GATE) held in the summer of 1974, identical tethered sonde packages were flown to heights of 1000 m from two ships separated by approximately 2 km. The differences in the profiles and fixed level time series from the two packages are a measure of the amount of spatial variability in the tropical marine boundary layer.

The observed spatial variability indicates what limits exist on the large-scale representativeness of all the GATE boundary layer tethered sonde data.

THE PBL STRUCTURE IN THE GATE FIRST PHASE

D. Hume and M. Miyake

The time evolution of the Planetary Boundary Layer (PBL) over Canadian Coast Guard ship Quadra through the passage of a convective system is discussed. The interaction of the energy transfer process at the ocean surface during the evolution of the convective system is discussed as to its variation in time and space.

A COMPARATIVE STUDY OF MARITIME TROPICAL AND TEMPERATE CONTINENTAL PRECIPITATION LINES

G. Austin and M. Haynes

Comparison of photographic weather radar records obtained in Montreal, Barbados and the GATE area of the Tropical Atlantic with the upper air soundings yields the results that the Montreal and Barbados lines seem generally similar except for the larger size of the Montreal lines. The GATE lines are odd in moving with their direction of elongation more nearly parallel to their orientation.

TROPICAL CUMULUS CLOUD POPULATION AND ITS PARAMETERIZATION

Han Ru Cho

Tropical cumulus cloud populations determined from the large-scale heat and moisture budgets indicate that cloud spectrum has usually a bi-modal distribution. Shallow clouds are present practically everywhere in the tropical atmosphere. Deep cumulus clouds penetrating into the layer above 500 mb level are present in significant amount only in regions where there is large-scale low level convergence. Quantitative relationship between the cumulus cloud activities and the large-scale circulations will be presented. A semi-empirical scheme of cumulus parameterization will be discussed.

INTERNAL SURGES

D. Farmer and C. Lee

Observations of temperature profile time series at intervals along Babine Lake have disclosed the presence of internal surges propagating from south to north along the lake. These surges appear to start as internal solitary waves, that steepen at the trailing edge as they travel. Since the surges propagated past five thermistor chains and also through an array of current meters, it has been possible to examine their structure in some detail.

LONG WAVE PROPAGATION IN CHANNELS OF NON-UNIFORM DEPTH

Paul H. LeBlond

Calculation of long wave speed in rectilinear channels uniform along their axis but with non-uniform cross-channel depth profile can usually be performed only by numerical methods because of the presence of complicated variable coefficients in the differential equation. An approximate method has been found which allows direct computation of Kelvin and Poincaré wave speeds for arbitrary bottom profiles for which the depth departs only slightly from its average value. The approximations are compared to exact numerical results and applied to some natural channels.

TIDES IN GULFS

Christopher Garrett

The tidal response of a gulf is interpreted as a threestage process: (i) Direct forcing produces separate responses in the gulf and ocean, treating the mouth of the gulf as closed, (ii) The difference in elevations V_G and V_O at the mouth causes a mass flux $I = (V_O - V_G)(Z_O + Z_G)^{-1}$ through the entrance, where Z_O , Z_G are impedances, and (iii) This mass flux produces a response in both gulf and ocean. Resonances occur at minima of $|Z_O + Z_G|$, exactly as in the harbour theory of Miles (1971). The amplitude at the mouth of the gulf is $V_M = (Z_O V_G + Z_G V_O)(Z_O + Z_G)^{-1}$ and will, in general, change if the geometry of the gulf and hence V_G and Z_G are changed. Appropriate boundary conditions are discussed for a numerical model of a region within which engineering works are proposed.

TIDE-INDUCED RESIDUAL CURRENT IN MINAS CHANNEL AND MINAS BASIN

Kim Tai Tee

A two dimensional non-linear tidal model is used to study tide-induced residual currents in Minas Channel and Minas Basin at the head of the Bay of Fundy. Four strong eddies in the residual current, with strength up to 1.5 knots, were obtained from the numerical calculation. These results are strongly supported by the observations available. It is found that these residual currents are generated by inertial effects.

NINTH ANNUAL GENERAL MEETING
CANADIAN METEOROLOGICAL SOCIETY

UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER
28 MAY, 1975

A G E N D A

The President in the Chair

1. Minutes of the 8th Annual General Meeting, 29 May 1974
2. Annual Report from the Executive
 - (a) President's Report
 - (b) Treasurer's Report
3. Annual Reports from the Committees
 - (a) Editorial Committee
 - (b) Awards Committee
 - (c) Citations Committee
 - (d) Standing Committee on Public Information (SCPI)
 - (e) Standing Committee on Matters pertaining to Atmospheric Science (SOMAS)
4. Annual Reports from the Local Centres
5. Budget for 1976
6. Membership Fees for 1976
7. Speaker's Tour
8. Location of Future Congresses
9. Other Business
10. Report of the Nominating Committee and Installation of Officers for 1975-76

PRESIDENT'S REPORT

The Canadian Meteorological Society in 1974

For the past two or three years the CMS has been evolving quite rapidly. The change is most noticeable in the finances of the Society with a budget that has grown by a factor of 2.8 from 1972 to 1975. This growth in the budget is due mainly to a grant that we are now receiving from AES. This grant amounted to \$10,000 in 1974 and may increase to \$16,000 in 1975. These do not include the \$2,000 that AES is contributing for subscriptions to *Atmosphere*.

Another important characteristic of 1974 is the fact that we received two donations. The first one amounting to \$2,000 was given by a member of the CMS for the advancement of meteorology. The second donation amounted to \$1,000 and was given by Rube Hornstein to create a prize in operational meteorology. The National Executive wishes to express its appreciation to these two members of the CMS for the interest that they show in our Society.

The improving finances of the CMS cannot do otherwise but reflect on the activities at both national and local levels. In 1974, our Centres received \$2,149 to support their regular activities and initiate new activities which could not be considered before because of a lack of funds. So far, this money has been well used and this support will be increased further in the years to come. In the course of 1974, the CMS started providing financial support to its Scientific Committee (SOMAS). This was originally a subcommittee created and financed by the National Research Council. It was transferred to the CMS so that it could more effectively play the important role of representing meteorological opinion to the public and governments, particularly at the provincial level.

As a scientific committee, SOMAS deals with matters that cover a wide range of activities and this includes the Canadian participation in the Global Atmospheric Research Program (GARP). In order to sustain an adequate participation, SOMAS created a National Scientific Committee for GARP which published a Plan for Participation in GARP towards the end of 1974. This is a substantial document reproduced in 2,000 copies and distributed around the world. Another achievement of particular significance was the contribution of the weather ship *Quadra* to GATE from June to September 1974. Some of the members of SOMAS and other scientists had to work hard for three years to obtain this contribution. The observational and scientific programs that were carried out on board this ship were coordinated through SOMAS and at present this committee is preparing a strategy for the use of the Canadian GATE data.

In 1973, the CMS modified its publication policy and decided to convert *Atmosphere* into a research journal. This conversion was completed in 1974 and it is expected that the size and quality of this journal will grow steadily in the coming years. All the general information material is appearing in the *Newsletter* which is now being distributed to all the members. The *Newsletter* is expected to grow in size and should then become a second regular publication of the CMS.

A booklet designed to describe professional, scientific and educational meteorological activity in Canada is in preparation and is expected to come out in 1975. Other publications on more controversial environmental issues are also being contemplated. Besides publications oriented towards the schools, the Public Information Committee of the CMS takes part in the news media activities related to meteorological issues or services. This form of action needs to be developed into a public information and education program that would operate through the existing channels for mass communication.

With its rapidly improving financial situation, the CMS will undoubtedly grow

into an organization capable of having a significant influence on the actions of the governments that have to face environmental problems. The social role of the CMS will gradually increase through SOMAS and through the Public Information Committee. This is the trend that was initiated some years ago and it will continue as long as the members keep asking for this particular type of evolution.

André Robert

TREASURER'S REPORT

The designation of a specific annual period for financial reports often makes it difficult to show the true financial position of an organization, especially when there are several outside influences. The accumulated surplus of \$11,992.14 as shown in the accompanying statement would, at first sight, indicate a healthy state of affairs in Society financing. It should be pointed out that this amount reflects several anomalous factors.

A considerable portion of the 1975 fees were precollected during the last quarter of 1974. The precollection of \$6737.14 represents about half of the Society's income from dues and subscriptions. This precollected amount is about four thousand dollars more than the amount collected during the same quarter in 1973. This increase reflects three things — more members are paying their membership fees during the last quarter, membership fees have been increased from 1973 and the membership of the Society has increased considerably during the past year. This difference is approximately the difference between the cash in hand at the beginning of the year and the year end balance.

The AES grant of \$10,000 is \$3,500 more than the previous year's grant. It should be kept in mind that the grant applies to the government's fiscal year, so that the monies on hand have to cover expenditures during the first quarter of 1975.

The Congress account shows a surplus of over two thousand dollars. Part of this is due to a small surplus during the 1973 Congress at Halifax. The major portion results from an unexpectedly high registration at the 1974 Congress at Toronto resulting in a windfall of close to two thousand dollars.

Several expenditures anticipated for 1974 did not materialize. SOMAS did not require all the funds originally allotted them. The anticipated expenditures of the Public Information Committee, while they did not occur, will be deferred.

Our position with the U of T Press was improved and the steadily increasing deficit in their account was wiped out.

In summary, the precollections, the portion of the AES grant committed to 1975 and monies committed during the past year but not yet paid will eliminate a considerable portion of the current surplus.

I. N. Yacowar

**CANADIAN METEOROLOGICAL SOCIETY
FINANCIAL STATEMENT
FOR YEAR ENDING DECEMBER 31, 1974**

RECEIPTS

Dues & Subscriptions	15561.49	
Sustaining Members	50.00	
Other	963.09	
Sale of reprints	1324.80	
AES Grant 74/75	10000.00	
Congress	<u>2228.00</u>	
		30127.38

EXPENDITURES

Operations	1557.95	
Commissions U. of T. Press	2712.30	
Grants to Centers	2149.00	
Publications	13695.85	
Congress	979.36	
SOMAS	1000.00	
SCITEC	325.00	
Reprints	<u>1274.03</u>	
		23693.49

Cash on hand Dec. 31/73	7600.10
U. of T. Press Acct.	<u>-2041.85</u>
	5558.25

Plus Receipts	30127.38
Less Expenditures	<u>23693.49</u>

11992.14

Royal Bank	
Dec. 31/74 Short Term dep.	10000.00
Dec. 31/74 Bank Acct.	<u>1653.70</u>

11653.70
<u>338.44</u>

U. of T. Press Acct.

11992.14

**CANADIAN METEOROLOGICAL SOCIETY
BALANCE SHEET
DECEMBER 31, 1974**

ASSETS

Royal Bank — Current Account	1653.70	
Royal Bank — Short Term Deposit	10000.00	
U of T Press Account	338.44	
Bell Canada — 12 shares at 43 5/8 (a)	523.50	
Canada Savings Bonds	950.00	
Canada Savings Bond series 24 matures coupons	437.00	
Eastern Canada Savings and Loan Debenture (b)	<u>1000.00</u>	
		14902.64

LIABILITIES

1975 Membership and subscriptions — received in 1974 (c)	6500.00	
Atmosphere 12 — 4 (c)	<u>2500.00</u>	
	9000.00	
Surplus Funds as at December 31, 1974	<u>5902.64</u>	
		14902.64

Notes: (a) value of shares as at December 31, 1974

(b) received from R. Hornstein — in trust

(c) estimated amounts only

AUDITOR'S REPORT

I have examined the records of the Canadian Meteorological Society and am satisfied that the Treasurer's Report presents a proper statement of the financial position as at December 31, 1974.

R. D. Easto
Auditor

BUDGET REPORT

The figures shown in the budget for 1976 are meant to be a true reflection of the activities that pertain to that specific financial period. Dues and subscriptions should remain steady at the current level, and with an anticipated increase in the AES grant, our projected income is expected to be close to thirty-three thousand dollars.

Our expenditures are expected to increase correspondingly with the SOMAS and Public Information commitments expected to materialize. Grants to Centres will be increased by nearly fifty percent to enable and encourage the Centres to expand their activities. Inflationary costs and some expansion will increase the costs of our publications. The cost of operations which, incidentally, includes commissions paid to U of T Press, will increase as the Executive moves West requiring a larger amount for travel.

I. N. Yacowar

CANADIAN METEOROLOGICAL SOCIETY BUDGET 1976

INCOME

Dues and Subscriptions	16000.00	
Other	900.00	
Grant	<u>16000.00</u>	
		32900.00

EXPENDITURES

SCITEC	700.00	
Centers	3000.00	
SOMAS	3000.00	
Information Services	2200.00	
Publications	17500.00	
Operations	<u>6500.00</u>	
		32900.00

EDITORIAL COMMITTEE REPORT

The present editorial committee took office in January 1974 with a mandate to promote the growth of *Atmosphere* as a research journal through the exercise of its editorial functions as well as whatever other measures it could devise. While the policy is to encourage an increase in the quality and quantity of research papers, *Atmosphere* should continue to publish review articles, critiques, commentaries, and other articles of a less specialized nature.

A modest start along these lines was made in 1974. The four issues of Volume 12 contained a total of sixteen articles, most of which were reports on original research. A notes and correspondence section was started. Six book reviews, one advertisement and several Society announcements were printed. For the first time, the usual summary of the annual congress was dropped, it being felt that this subject was adequately covered in the Congress Issue. A total of 34 manuscripts were received, of which 47% were accepted and published, 32% rejected, the remainder being either still out for review or returned for revision. This is a rather meagre flow of material. The majority of contributions originated from Canadian sources although a trickle from outside is beginning.

Measures taken to promote *Atmosphere* include an editorial in 12, 1 and a policy statement on the inside back cover of each issue. An advertisement was taken out in the May 74 issue of the Bulletin of the American Meteorological Society and will be repeated in April 1975. An effort has been made to find referees and book reviewers not just within the Canadian scientific community but outside as well. A list of about 100 additions to the complimentary subscription list (formerly 20) has been compiled. These are mainly institutions and libraries outside the country. They will remain on the list for about 2 years, at a cost to the Society of about \$2 each per year. Some names previously on the list were deleted.

A major, but still unrealized goal was to improve the timeliness of issue, each number to be in the mail by the end of the corresponding quarter. Because of the shortage of material, the schedule remains about one issue behind. A major effort was mounted to get this, the 9th annual congress issue out on time. The deadline for submission of abstracts was advanced by one month. An excellent response was received and the program committee succeeded in organizing their material in record time.

The cost of publishing *Atmosphere* remained fairly stable in 1974. The hoped-for increase in number of pages did not materialize. Each average 40 page issue cost roughly \$2500, including all charges for authors' alterations, postage, etc. The average press run was about 1100 of which 950 were paid for and distributed. The marginal cost for an increase in the press run is about \$50 per hundred and for an increase in size it is about \$200 per increment of 4 pages. The Congress issue costs roughly half as much as a regular issue, because it is not typeset and is printed on lower quality paper.

The committee hopes that many of the contributors to this year's Congress will submit written versions of their papers for consideration for publication in *Atmosphere*. This invitation is extended to papers on oceanography with some bearing on meteorology; the CMS subcommittee on oceanography has agreed to assist in the review of such papers.

Ian D. Rutherford
Editor, *Atmosphere*

AWARDS COMMITTEE REPORT

The Awards Committee (Members: C. D. Henry, Cynthia Wilson, Charles Young, Douglas Leahey) offers the following recommendations for the year 1974:

President's Prize: Dr. Gordon A. McBean
(Nominated by the Toronto Centre)

For his many important contributions to boundary layer meteorology, his active role in the affairs of the Toronto Centre, and, in particular, for his paper, "The turbulent transfer mechanisms: a time domain analysis", presented at the 5th CMS congress and published in the *Quart. J. R. Meteor. Soc.*, **100**, 53-66, 1974.

Prize in Applied Meteorology: Dr. Roger Daley
(Nominated by the Montreal Centre)

For his pioneer and incisive work on the development of a successful operational Spectral Forecast Model. This Model is under continuous development at the CMC and is also being tested at the NMC in the United States. An early version was presented to the 8th CMS Congress as "A Semi-Implicit Global Multi-level Primitive Equations Model".

Graduate Student Prize: Geoffrey Strong
(Nominated by the Alberta Centre)

For his thorough investigation and thesis work on "The Objective Measurement of Alberta Hailfall", (U. of Alberta-1974). This material was also the subject of a presentation to the Alberta Centre.

For the first time the committee is happy to report many well documented nominations by Centres and by individuals – the selection process was thus easy, only the final choice from all the worthy candidates was difficult.

B. W. Boville,
Chairman

CITATIONS COMMITTEE REPORT

The Committee recommends that the following be awarded CMS Citations for the reasons noted:

1. To Barbara Frum, Alan Maitland, Harry Browne and the staff of the CBC program "As It Happens" in recognition of their outstanding contribution to public awareness of the environment by their diligent research and responsible reporting with respect to lead poisoning in Toronto, mercury contamination in northern Ontario, arsenic pollution in Yellowknife and the effect of asbestos on the health of workers in Thetford Mines. A well-informed public is essential

- to the solution of environmental problems and "As It Happens" has provided valuable information to the public.
2. To the Alberta Environmental Conservation Authority in recognition of its outstanding contributions, as a provincial agency, to establishing environmental ethics and to alleviating pollution problems. Through its numerous public hearings on varied pollution problems, the Authority has not only sensitized the public to the critical importance of the quality of the environment but charted the course of the provincial efforts towards this goal, in the best interest of the people of Alberta.
 3. To Lydia Dotto, in recognition of her outstanding reporting, as the science writer for the *Globe and Mail* newspaper, on meteorological and environmental matters. Her extensively researched and accurate articles, especially the series on the interaction between man and climates, have played an important role in ensuring that the public are kept well informed on a wide range of pressing environmental problems.

J. Maybank,
Chairman

REPORT OF THE STANDING COMMITTEE ON PUBLIC INFORMATION (SCPI)

The members of the committee for 1974-75 were as follows:

J. Vanier	Chairman
H. B. Kruger	Liaison officer (AES Headquarter)
Dr. A. J. Chisholm	Toronto Center
D. A. Faulkner	Vancouver Center
M. G. Ferland	Centre Quebecois
H. M. Fraser	Winnipeg Center
A. D. Gates	Halifax Center
J. R. Hendricks	Regina Center
A. Ouellet	Centre de Montreal (langue francaise)
Vacant	Montreal Center (English language media)
D. J. Webster	Ottawa Center
H. P. Wilson	Alberta Center

It seems that everything is going smoothly and well across the country since not much feed-back was received from the various centres at the meetings of Council. Does this assertion reflect the true image of the discipline of meteorology in Canada, that it does not evoke any discussions; or is there simply a lack of interest on the part of CMS members in making their council aware. We tend to believe that it is the second option, unfortunately, that is most representative of the present situation. One would have a hard time to believe that suddenly meteorological activities are fully understood and giving entire satisfaction to everyone concerned.

Nevertheless, some activities occurred last year within the scope of the committee and a brief outline follows:

1. The "Ask Andy" syndicated column continued to be published on subjects

regarding meteorology. The number of columns involving a meteorological subject seems to have decreased over the last year; whether because of a week feed-back or lack of interest, it is impossible to assess. In each case in which a newspaper clipping was received, a letter was sent to the newspaper's chief editor expressing the Society's interest and pointing out the low quality of this column.

It is a difficult case to handle and the best we can hope for is that this column runs out shortly of imagination and (negative) creativity.

2. Information Canada produced a leaflet on meteorology and related disciplines. This leaflet was produced by their press service "FOTOMEDIA". Their aim is to describe an activity, in our case meteorology, with pictures and the smallest number of words possible. A few hundred pictures were taken leading to a montage of excellent quality.
3. Reader's Digest, in their July 1974 edition, published an article called "ominous Changes in the World's Weather". This article, a condensed one, was written by Tom Alexander and subsequently translated and published in the *Reader's Digest* French magazine *Selection*.

The article was sent to various specialists in climatology for proof reading.

The consensus was that even if the journalism was a bit blasé, the article contained an important message.

The committee sent a letter to the *Reader's Digest* Public Affairs Co-ordinator, expressing to him our concern with this category of article. It was proposed to them that the CMS would furnish them a proof reading service for any articles on meteorology they would like to publish in the future. At the same time, the committee suggested to them, since *Reader's Digest* claims it is a Canadian magazine, to use Canadian material and experts who could produce articles closer to the Canadian reality and its needs. *Reader's Digest* was made fully aware that Canada has all the expertise in meteorology that they may require. It appears that our efforts bore fruit, since a few months later, the Committee received a call from *Reader's Digest* asking information and contact points relative to their plan to publish an article on meteorological activities in Canada. The request was then dispatched to the various sources of information.

4. Mr. Sam Raddi, President of COPE (Committee for Original Peoples Entitlement) sent to the CMS a voluminous report on plans for off-shore Drilling in the Beaufort Sea. In the report he requested information on how CMS regards the problems connected with off-shore drilling. After the SCPI read this report carefully, it became evident that the problems outlined in the COPE report were not related to meteorology nor even to ecology at large, but more-or-less a plea to use local manpower and for the protection of the local Inuit identity. SCPI had to reply to Mr. Raddi expressing its regret for not taking any action because the issue of the referenced paper was more political than scientific, and it was a duty for the Society to respect each member's political feelings and opinions.
5. On the 22nd of November 1974 the *Gazette*, a Montreal newspaper, published a front page article with the headline title "Weatherman didn't want to frighten us". This was in reference to a snowstorm that occurred the day before which was the first of the year, dumping four inches of snow with strong winds.

It was felt that this type of article does the most damage to the image of meteorology and that prompt action should be taken to correct any false impressions which may have been left with the general public.

The O.I.C. of the Forecast Office in Montreal and the Quebec Regional Director of AES were made aware of this situation. An inquiry of the events

was made and the Regional Director of AES, R. J. Fichaud took the responsibility to send a lengthy explanation to the *Gazette's* News Director. In summary, the Regional Director's letter stated that the *Gazette's* reporter phoned the weather office without identifying himself and talked to the duty forecaster. The information made available to him and produced in the article was taken out of context and published in the paper to make a sensational article. It was pointed out that such an attitude is almost professional dishonesty.

6. A radio station in Montreal, which claims in its publicity that they are giving information of the best quality, had a disc-jockey who on his weekly program had his own way of converting the temperatures in degrees F to C by subtracting 32 from degrees F. Most media give the parameters in both units at the same time. The radio station was contacted on that case and made aware of the incompetence of their disc-jockey, it was also brought to their attention that, as well as broadcasting false information, it was contributing to increasing the confusion of the layman who is already in the stage of changeover from one system to another.

Proper action was taken by the radio station and a *mise au point* was broadcast several times the following week.

7. Last year it was announced that CMS would publish a booklet for public dissemination. It was agreed that the booklet theme would be "Meteorology in Canada" and would deal in particular with career opportunities in Meteorology and with the goals and activities of the CMS.

All members had been requested to supply ideas, photographic material, etc. to Mr. J. J. Moakler who acts as editor.

Very little information was received by the committee or Mr. Moakler. It was hoped that the publication would be available for this congress, but since Mr. Moakler had several personal problems to solve and that he had to do the entire work himself, it will be virtually impossible to produce the booklet on time.

As of March 2nd, Mr. Moakler has on hand a draft that is being proof-read by some of his acquaintances who have experience in that field.

The draft should be available to the CMS executive by the end of March and if accepted would go directly for publishing and may be ready for the CMS Congress.

There is very little time left to meet the deadline but the committee is making every effort to try to respect it.

Once again the committee concludes this report by asking all members to contact their local center and inform the SCPI representative on everything which may advise the Executive Committee of the CMS on matters within the Society which might require the provision of information to the public in general or to specific groups.

We are sure that the conversion of our measurement system to SI should produce enough discussions that there will be room enough for everyone to report to the SCPI.

Jacques Vanier
Chairman

REPORT OF THE STANDING COMMITTEE ON MATTERS PERTAINING TO ATMOSPHERIC SCIENCE (SOMAS)

The current membership list of the Committee is as follows:

Expiring in 1975:	Professor J. Derome Dr. C. L. Mateer (Secretary)
Expiring in 1976:	Professor F. K. Hare Professor R. List (Chairman) Dr. J. Maybank Professor S. Orvig
Expiring in 1977:	Dr. D. M. Leahey Mr. S. M. Nikleva Dr. G. A. McBean Dr. S. D. Smith Mr. G. D. V. Williams
Ex Officio:	Dr. A. Robert, President, CMS Professor A. W. Brewer, GARP Co-ordinating Committee (GCC) Dr. W. L. Godson, Director-General, Atmospheric Research Directorate Professor P. L. Merilees, Chairman, GARP Scientific Committee

Dr. Boville was Acting Chairman for the period April 1 to August 31, 1974, during the absence of Professor List.

The committee meets on March 13, 1975. The results of this meeting were not known at the time this report was prepared.

Terms of Reference

The committee received preliminary guidelines describing its responsibilities and mode of operations from the Executive Committee of the CMS. They are being made available for approval.

Budget

That the budget be approved and forwarded to CMS executive.

Activities of SOMAS in 1974/75.

1. The Canadian GARP Scientific Committee (GSC) continued as a subcommittee of SOMAS. Professor Merilees was appointed Chairman. The up-to-date statement "Canadian Plans for Participation in GARP" has been published.

2. The effective participation of the Canadian scientific community in GATE was made possible through the leadership provided by AES and in particular by Dr. A. Collins. This experiment represents a big milestone in Canadian meteorology, and GSC and SOMAS are undertaking every effort to make sure that the data are going to be exploited as much as possible.

3. There will be a joint CMS-CAP session at the CAP meetings at the University of Toronto in 1975. Dr. Evans is in charge of the CMS/SOMAS part.

4. The ACGG/NRC Committee has been disbanded. Its international functions in relation to IUGG are taken over by the Canadian National Committee (CNC). CNC is carried by the scientific societies within the realm of IUGG. CMS is represented by two members: the chairman of SOMAS and Dr. Boville.

5. Preliminary discussions have been carried out within SOMAS about how to take care of the scientific and professional aspects of the oceanographic components of CMS. A committee was appointed for this purpose, comprising Dr. Smith (Chairman), Professor Miyake, and Dr. C. Mann.

6. A review of highlights in meteorology in Canada will be given at the CMS Congress.

Roland List
Chairman

REPORTS FROM LOCAL CENTRES

B.C. CENTRE

Chairman:	G. Schaefer	Headquarters Pacific, AES
Secretary-Treasurer:	M. Horita	Pacific Weather Central
Program Directors:	Dr. T. Oke	Dept. of Geography, UBC
	Dr. T. A. Black	Dept. of Soil Science, UBC

Five meetings of the Centre were held before March, with another two planned to take place before the season's end.

October 29	J. L. Knox, Regional Director-AES Pacific Region "Weather Forecasting-Historical Perspective and Future Possibilities"
November 19	M. Rose, Operational Development Unit-Pacific Weather Central: "Quantitative Precipitation Forecasting"
December 10	H. Raynor, Pacific Weather Central: "Weather Forecasting for the Forest Industry"
January 30	Prof. P. E. Merilees, Dept. of Meteorology, McGill: "General Circulation Models: Progress and Promise"
February 18	P. Schaerer, NRC B. C. Research, UBC: "Avalanche Hazard Forecasting"
March 6	Prof. A. B. Fraser, Assoc. Prof. Dept of Meteorology, Pennsylvania State Univ: "Mirage, the Green Flash and Theological Optics"
April	Dr. M. B. Danard, Dept of Mechanical Engineering, Univ. of Waterloo: "Topographic Effects on Surface Winds"

Throughout the season the Executive have had numerous meetings to plan the 9th Annual Congress of the CMS. It is our hope that all attending will find the 1975 Congress both interesting and enjoyable.

1974 Financial Statement

Income

Cash on hand January 1, 1974	36.92
Grant from National Executive, Jan.	172.00
Bank interest, April	.52
Bank interest, October	1.99
Grant from National Executive, Nov.	213.00
Grant for 1975 CMS Congress, Dec.	500.00
Total	\$924.43

Expenses

Deposit to Stanley Park Pavilion, Jan.	50.00
Bank service charge, Jan.	00.00
Entertainment Expenses, Dr. Davenport, May	26.30
Notices for meetings, printing costs	16.35
Stamps, envelopes and refreshments for meetings	32.20
Total	\$124.85

Credit balance, Feb. 17, 1975 \$799.58

M. M. Horita
Secretary-Treasurer

ALBERTA CENTRE

Executive of the Centre during 1974-75:

Past Chairman:	Mr. F. E. Burbidge, AES Western Region, Edmonton
Chairman:	Dr. E. P. Lozowski, Department of Geography, Division of Meteorology, University of Alberta
Secretary-Treasurer:	Mr. L. Wojtiw, Alberta Research, Edmonton
Calgary Representative:	Dr. D. M. Leahey, Western Research and Development Ltd., Calgary.

The Centre has held four meetings at the time of writing and plans another two. These meetings have been well supported by the membership, with attendances of 20 to 30 persons. The speakers and topics are listed below:

November 6, 1974	Dr. R. E. Munn, "Monitoring the world environment"
November 20, 1974	Dr. D. M. Leahey, "Air pollution modelling for the city of Edmonton"
January 15, 1975	Dr. P. Lester, "The real time forecasting of lee waves"
February 4, 1975	Dr. P. E. Merilees, "General circulation models - problems and progress"
March 1975	Dr. M. English, "Modelling hailstorms"
April 1975	Dr. R. Bryson, "Climatic change" (This will be a joint meeting with the Alberta Geographical Society and the Institute of Earth and Planetary Physics, University of Alberta)

The CMS continues to be active in public affairs in Alberta, being represented on the Public Advisory Committee of the Environment Conservation Authority, and on the Alberta Weather Modification Board. Use of the annual subvention has so far been limited to covering local administrative costs and defraying some of the expenses of visiting speakers. We are still seeking innovative means to use these funds both to proclaim and promote the Society's goals in service to the provincial community.

Edward P. Lozowski
Chairman

Financial Statement

Income

Bank Balance Forward from June 1, 1974	\$186.06
Alberta Centre Grant	228.00
Interest	2.81
	416.87

Expenses (June 1, 1974 to Feb 28, 1975)

Postage	14.70
Expense of Bringing in a Speaker	50.90
Coffee Fund	.54
	66.14
 Balance as of Feb 28, 1975	 \$350.73

L. Wojtiw
Secretary-Treasurer

REGINA CENTRE

The following is a report of the Activities of the Regina Centre for the 1974-75 year.

At the first meeting of the year, held in November 1974, Mr. Roger Baldwin of Water Planning and Management, Environment Canada spoke on "1974 Flood at Moose Jaw". This was a very well attended meeting.

The next meeting of the Centre was a dinner meeting at which Dr. Philip Merilees gave his lecture on "General Circulation Models-Progress and Promise." This was held in the Regina Inn on February 5 1975.

The third meeting of the year is expected to be held in March and will be addressed by Dr. Stanley R. Shewchuk of the Saskatchewan Research Council, Saskatoon. His topic will be Air Pollution and Potash Mining in Saskatchewan (Plume Dispersion).

Other activities include a display at a Regina shopping plaza for World Meteorological Day.

Financial Statement:

Balance January 1, 1974	\$ 9.05
Balance February 13, 1974 s.c	.20
Subvention November 14, 1974	180.00
Coffee supplies November 14, 1974	4.09

Balance December 31, 1974 \$184.96

R. J. O'Brien
Secretary

WINNIPEG CENTRE

Summary of meetings:

1. September 26, 1974, dinner meeting at the Officer's Mess, CFB Portage la Prairie, Manitoba. The speaker was Carl Shaykewich of the Soil Science Department, The University of Manitoba. He discussed agriculture in central Manitoba as related to climatology.

2. November 7, 1974, dinner meeting at *The Old Spaghetti Factory* in Winnipeg. The speaker was Hugh McKay of Water Resources Branch, Government of Manitoba. He talked of lake level management in Manitoba.

3. January 29, 1975, dinner meeting at *Lock, Stock and Barrel* in Winnipeg. The speaker was Professor Merilees, Associate professor at McGill University. He discussed general circulation models, progress and promise.

Financial Statement February 12th 1975

Cash on hand as of April 18th, 1974	\$143.56	
Incidental expenses (including postage)		\$ 13.90
Dinner meeting April 18, 1974	124.00	134.40
Burn Lowe Award 1974		10.00
Science Fair Awards		78.66
Dinner meeting October 4, 1974	90.00	80.08
Dinner meeting November 7, 1974	13.00	17.07
Received from national executive	206.00	
Interest on bank account	.74	
	\$577.30	\$334.11
Cash on hand as of December 31, 1974	\$243.19	

Additional information required prior to April 18th, 1974 may be obtained from last years annual report.

D. S. Siemieniuk
Secretary-Treasurer

Speakers Program

A proposed talk in October by the distinguished Swiss Meteorologist, Dr. Valko, was cancelled when a family illness precluded his Canadian visit.

The session opened, therefore, on November 3rd with a stirring address by Professor J. A. Livingston, Faculty of Environmental Studies, York University, entitled "The Arctic Dilemma". Mr. Livingston, an eminent author and environmentalist, outlined an impending crisis facing the tundra ecology due to inadequate environmental assessment procedures and policies currently being practised.

Dr. F. K. Hare, Director of the Institute for Environmental Studies, University of Toronto, presented on December 3rd, a talk "Weather and Environment: the Role of the University of Toronto," in which he discussed the new structure and planned work of the University's Cross-faculty facility for environmental research.

On January 22nd, Dr. Alan Falconer, Department of Geography, University of Guelph, spoke on "Application of Earth Resources Satellite Data to Environmental Studies." The lecture was colourfully illustrated using multispectral remotely-sensed imagery in several Canadian situations.

The address of Dr. Phillip Merilees, "General Circulation Models: Progress and Promise" has been scheduled for February 26th.

It is anticipated that two to three additional meetings will be held during the 1974-75 session of which a tour and social evening are envisaged. All meetings to date have been held in the auditorium of the AES headquarters building. Attendance has ranged from 100 to 30. Each talk has been greeted with lively discussion, and the evenings have been terminated by informal discussion over coffee and doughnuts in the foyer.

Other Activities

The Centre plans to present a film on a meteorological subject to the Boy Scouts Association Library which will be circulated without fee to interested scouting and Guide groups in Ontario.

Our contact with educational authorities, particularly in outdoor education, has been strengthened and advice on instrumentation and measurement-interpretation exercises has been given.

Executive 1974-75

Chairman	B. F. Findlay	Atmospheric Environment Service
Program Chairman	Dr. J. Padro	Atmospheric Environment Service
Secretary	Dr. N. B. A. Trivett	University of Guelph
Treasurer	J. E. Campbell	Atmospheric Environment Service

Financial Statement

Balance 31 December 1973		\$342.05
Stationery	\$ 22.65	
Postage	23.94	
Notices	44.66	
Meetings	80.28	
Typing	20.00	
Instruments *	221.00	
Subvention	\$352.00	
Congress (York)	<u>543.94</u>	
Total Debits		\$412.53
Total Credits	\$895.94	
Balance 31 December 1974		\$825.46

* Purchased on behalf of CMS for Toronto Island Natural School.

OTTAWA CENTRE

The Executive for 1974-75 consisted of: Ken Clark, Chairman; Don McCormick, Vice-Chairman; Tony Rutkus, Public Information; and, Blake Watson, Sec-treas.

Summary of the Meetings 1974-75

1. September 25th, a lecture meeting. The speaker Bernard A Power, of the Weather Engineering Corp of Canada, Montreal. Mr. Power discussed the history of weather modification, and the use of explosive nuclei generators by the United States in Southeast Asia, and their use elsewhere to augment the world food supply.

2. November 28th, a dinner meeting and ladies night. The speaker Don C. Archibald. Don's talk on the Antarctic reviewed the history of its exploration, the means of travel and clothing requirements, and was illustrated by a large number of excellent slides.

At this meeting the Canadian Meteorological Society Citation to Dr. P. D. McTaggart-Cowan "for his pioneering work in the organization of oil-spill clean-up operations, for publicly exposing the general negligence which characterizes many tanker operations, and for his far sighted recommendations, . . . , on how to minimize and deal with oil spills". In accepting the Citation, Dr. McTaggart-Cowan was obviously pleased, and indicated that he would use the citation to agitate the bureaucracy. He indicated that even now, 4 years after the spill, Canada still had only a "band-aid" preparation for future spills. He charged the Canadian Meteorological Society to speak out and agitate the bureaucracy into action on the recommended oil-spill research, and also to speak out on the subject of climatic change and food.

3. January 22nd, a lecture meeting. The CMS/AES speaker Philip E. Merilees speaking on General Circulation Models.

4. February 26th, a lecture meeting. The speaker, Jim Bruce, Dir-gen. Inland

Water Directorate, Dept. of the Environment, speaking on Meteorology and Water Resources.

5. April 16th, a lecture meeting. Gord A. McKay, Meteorological Applications Branch, speaking on Meteorological Applications.

MONTREAL CENTRE

Past Chairman:	R. Robinson	Canadian Meteorological Centre, AES
Chairman:	A. Boucaud	Canadian Meteorological Centre, AES
Secretary:	R. Gagnon	Montreal Weather Office and UQAM
Treasurer:	S. Lambert	McGill University

For the year 1974-75 the present executive decided to invite both French and English-speaking speakers. It was also decided, at an early meeting, that the conferences would be held in different locations to encourage more members to be present. We held our meetings at the McGill University Faculty Club, at the Canadian Meteorological Centre (CMC) and at l'Université du Québec à Montréal (UQAM).

Six meetings of the Centre were held before March, with another three planned to take place before the season's end.

- | | | |
|-----------|----|--|
| September | 17 | Dr. P. E. Merilees, Department of Meteorology, McGill University: "The estimation of horizontal truncation errors using the - 3 law for kinetic energy". |
| October | 22 | Dr. H. Sundqvist, Dynamic Prediction Research Division, AES: "Model tropical cyclone behaviour in experiments related to modification attempts" |
| November | 26 | Dr. M. D. Levine, McGill University: "Picture Processing, Picture Analysis, Pattern Recognition, Scene Analysis - which one do I mean?" |
| December | 10 | Mr. B. Saulnier, L'Institut Brace, Collège Macdonald: "Les Potentiels des Energies Solaire et Eolienne". |
| January | 14 | Dr. A. Robert, Directeur du Centre Météorologique Canadien (CMC): "Computation Resolution Requirements for Accurate Medium Range Numerical Prediction". |
| February | 4 | Dr. D. Winstanley, Environment Canada, Ottawa: "Climatic Changes and the World Food Situation". |
| March | 11 | Dr. P. E. Merilees, Department of Meteorology, McGill University: "General Circulation Modelling". |
| April | 15 | Dr. P. Dansereau, Centre de Recherche en Sciences de l'Environnement, Université du Québec à Montréal: "Les Problèmes de l'Environnement Canadien". |
| May | 20 | Dr. G. R. Lindsey, Department of National Defence, Ottawa: "Global Nuclear Strategy". |

With the possibility of another meeting to be held at the very beginning of May.

This year, for the first time, the February meeting was held in collaboration with the Sigma-Xi Society of McGill University. This meeting was a true success, gathering over 150 persons. For that occasion Dr. D. Winstanley was speaking on a subject of general interest and many wives accompanied their husband-members. This experience is proposed to be continued next year.

At the April meeting, which will feature another topic of general interest, it is intended to use press media to gather the largest number of persons possible. Mr. Arnel Boutard, directeur du département de Physique à l'Université du Québec à Montréal, being our host will be invited to make a short exposé of the first M. Sc. program in meteorology in that university. Dr. Pierre Dansereau's address will be followed by a relaxing cheese and wine party. It is hoped to have the press on the spot for that occasion in an effort to make our society better known and to complete our membership drive.

The main project of the year, which will be realised in March and April, is a series of conferences given by teams of members in as many Montreal CEGEP's as possible. The idea is to inform students of our society and of the Canadian Weather Services.

Financial Statement

Operating Account

1) Revenues	
Balance 16 May 1974	\$ 71.52
Annual fees	33.00
Refreshments	15.33
CMS Central's grant	249.00
TOTAL RECEIPTS	\$368.87
2) Expenditures	
Stamps	\$ 1.50
Cheques	.60
Refreshments	25.00
Faculty Club room rental	126.12
TOTAL EXPENDITURES	\$153.22
SURPLUS	\$215.65

Capital Account

Net assets as of 16 May 1974	\$ 71.52
Net capital increase	144.13

CENTRE DE QUEBEC

A son assemblée générale de mai 1975, la Société de Météorologie de Québec fêtera son onzième anniversaire de fondation et cet événement couronnera également la sixième année d'affiliation de cette société à la Société Météorologique du Canada. Voici un résumé des activités entreprises ou réalisées au cours du présent exercice:

Le Bureau d'administration a tenu cinq réunions dont les principales décisions ont porté sur les points suivants:

- a) Lancement d'une invitation officielle du Centre de Québec à la Société Météorologique du Canada de tenir son Congrès annuel de 1976 à Québec, précisément à l'université Laval. Cette invitation ayant été acceptée, le Bureau d'administration s'est mis à la tâche de préparer les grandes lignes de marche à suivre pour la préparation et la réalisation d'une réunion de cette envergure.
- b) Participation d'un membre du Conseil, M. Robert Boudreault, à un colloque interdisciplinaire sur le "Développement du Moyen-Nord" tenu à Chicoutimi, les 17, 18 et 19 octobre 1974.
- c) Actuellement, le Bureau d'administration étudie la façon la plus valable d'utiliser la subvention de \$105 que la Société Météorologique du Canada a accordée à notre Société. La première possibilité envisagée est l'achat d'une station météorologique mobile qui serait mise à la disposition de groupes d'étudiants; la deuxième suggestion est l'impression d'un document à but éducatif pour informer le monde enseignant sur le domaine météorologique. L'impact éducatif et le coût respectif de chacune de ces suggestions déterminera le choix à effectuer.

Au cours de l'exercice 1974-75, six réunions d'information publique étaient au programme des activités. En voici les conférenciers et les sujets, dans l'ordre chronologique:

Le 8 Octobre 1974

Dr. Gabriel Godin, du Service des données de l'Environnement marin à Ottawa.

-Sujet: La marée à Québec: l'influence du vent, de la pression atmosphérique, des fronts et du débit du fleuve.

Le 1er novembre 1974 (Conjointement avec la Société Linnéenne)

M. Jacques Bureau, du Service de l'Environnement atmosphérique à l'aéroport de Québec.

-Sujet: Les cocasseries en météorologie.

Le 10 décembre 1974

Dr. Joseph Litinsky, du département de géographie à l'UQATR

-Sujet: Types de temps.

Le 14 janvier 1975

M. Raymond Desjardins, du ministère de l'Agriculture à Ottawa.

-Sujet: Mesure du bilan énergétique et la production agricole.

Le 11 février 1975

MM. André et Guy Leclerc, hydrologues.

-Sujet: Modèle mathématique de précipitation pour l'étude du ruissellement naturel et urbain.

Le 19 mars 1975

M. Philippe Merilees, du département de Météorologie à l'université McGill (Conférencier de la Société météorologique du Canada)

-Sujet: Modèles de prévisions atmosphériques.

Ces conférences ont été présentées à la faculté des Sciences de l'agriculture et de l'alimentation de l'université Laval, à l'exception de celle du 1er novembre qui a été présentée à la salle Marquette du Collège des Jésuites, 1150, Boul. St-Cyrille Ouest.

Pour l'exercice qui prend fin, les registres de la Société de Météorologie de Québec comptent quelque 60 membres.

Le Conseil sortant se compose comme suit:

Président:	M. Michel Ferland
Vice-président:	M. André Hufty,
Conseillers:	MM. Robert Boudreault, Pierre-André Dubé, André Fréchette, Paul Lamb, André Plamondon,
Secrétaire:	M. Gaétan Soucy
Trésorier:	M. Gaétan Soucy

Rapport du Trésorier Exercice 1974 (1er janvier au 31 décembre 1974)

Actif

Actif en caisse au début de l'exercice	\$ 441.01
Cotisations (60)	120.00
Octroi du MRN	500.00
Subvention de SMC (Tournée de conférences)	164.00
Octroi de SMC	105.00
Bonis	.42
Intérêts	.68
Remboursements de timbres	1.28
Total	\$1332.39
Capital social	5.00
Actif total	\$1337.39

Passif

Frais de séjour et de déplacement des conférenciers	\$ 256.80
Frais de la tournée d'un conférencier spécialiste	239.00
Achat de timbres et de matériel de bureau	46.82
Impression de lettres et d'enveloppes	64.59
Location de salle	35.00
Frais de secrétariat (dactylographie)	25.00
Frais de réception	200.00
Frais de déplacement et de représentation du Conseil	116.80
Frais d'administration à la caisse populaire	2.00
Total	\$ 986.01
Immobilisation du capital social	5.00
	\$ 991.01
Excédant de l'actif sur le passif	\$ 346.38

Gaétan Soucy
Secrétaire-trésorier

HALIFAX CENTRE

The centre held six meetings during the past year, the speakers and topics were:

January	29, 1974	Dr. R. Shaw, "The Role of the Environmental Protection Service in Air quality Control"
February	27, 1974	Mr. G. Lally, "Ice Formation in the Gulf of St. Lawrence"
April	11, 1974	Prof. A. G. Davenport, (CMS/AES lecture tour), "Strong Winds and Structures"
May	11, 1974	Mr. Ken Devine, "Occurance of High Winds off the East Coast" Mr. Ron Bishop, "Feasibility of Using Isobaric Prognosis to Predict Altimeter Settings off the East Coast"
October	17, 1974	Mr. Leslie A. Wood, "Life and Times on Sable Island"
December	10, 1974	Mr. D. Bellows, "Dynamical Approaches in Meteorological Forecasting"

The May meeting of the Halifax Centre was held at Canadian Forces Base, Greenwood. This meeting included a tour of the Meteorological facilities with supper at the Officers' Mess and was attended by members and their wives.

The Halifax Centre is purchasing a set of weather instruments for a large Halifax high school. This gift will cost approximately \$325.00 and will be followed up with instructions on their use, and the use of weather observations; by members of the Halifax Centre.

The current executive of the local are:

CHAIRMAN	Mr. Ron Hopkinson
VICE-CHAIRMAN	Dr. Stu Smith
SECRETARY-TREASURER	Mr. Fraser MacNeil

The following is a brief financial statement for calendar year, 1974.

Receipts

Funds on Hand January 1, 1974	\$ 812.25
Interest April 30, 1974	12.15
CMS Grant June 6, 1974	136.00
Interest November 26, 1974	10.64
CMS Grant November 26, 1974	<u>225.00</u>
Total	\$1196.04

Expenses

Prof. Davenport Lecture April 17, 1974	\$ 15.00
Refund of Conference Advance to National Executive (1973 Congress) June 6, 1974	100.00
Refund of Surplus from 1973 Congress December 18, 1974	<u>342.26</u>
Total	\$457.26
Total Assets	\$1196.04
Total Expenses	<u>457.26</u>
Balance	\$ 738.78

Present outstanding Expenses:

School Weather Instruments	\$325.00
Postage Expense owing past secretary	<u>19.00</u>
Total	\$344.00

C. F. MacNeil
Secretary-Treasurer

NOTICE OF MOTION FROM COUNCIL

- I. It is moved that *By-Law 12 Local Centres* be amended by:
- i. replacing paragraph b) by
 - b) The Officers of a Local Centre shall include a chairman, a secretary and a treasurer, and such other officers as a Local Centre may decide. Each Officer of a Local Centre must be a member of the Society in good standing.
 - b) Un centre local doit avoir comme directeurs, un président, un secrétaire et un trésorier; il peut également nommer tout autre membre qu'il juge à propos de désigner. Chaque directeur d'un centre local doit être un membre en règle de la Société.
 - ii. adding a paragraph
 - g) The treasurer of a Local Centre shall submit to the Executive an annual financial statement, based on the calendar year, by March 1st of each year.
 - g) Le trésorier d'un centre local soumettra au bureau d'administration un rapport financier annuel, basé sur l'année civile, le 1^{er} mars de chaque année.
- II. It is moved that the *Appendix to By-Laws* paragraph
- d) *The Dr. Andrew Thomson Undergraduate Student Prize* be deleted and replaced by
 - d) *The Rube Hornstein Prize in Operational Meteorology* A Prize known as the Rube Hornstein Prize in Operational Meteorology may be awarded in any year for outstanding service by an individual engaged in providing operational meteorological service in its broadest sense, but excluding the publication of research papers as a factor, unless that research is already incorporated as an aid in the day-by-day performance of operational duties. The work for which the prize is granted may be cumulative over a period of years or may be some notable achievement of the previous year.
 - d) *Prix de météorologie appliquée Rube Hornstein*
Le prix de météorologie appliquée Rube Hornstein peut être décerné, à chaque année, à un individu pour un travail exceptionnel dans l'exploitation des services météorologiques, au sens large du terme, en excluant cependant comme critère d'évaluation les publications scientifiques, à moins que les résultats de ces recherches ne soient déjà utilisés pour améliorer la performance au jour le jour des services d'exploitation. Le travail peut avoir été effectué durant plusieurs années précédant l'année en cours, tout comme il peut n'avoir été réalisé que l'année précédents.
- III. It is moved that:
- i. *By-Law 6 Committees* be amended by adding
 - g) A Citations Committee shall be established. The Committee shall be responsible for recommending candidates for the award of citations by the Society

and shall review annually the desirability of modifying the terms of reference for the award of citations.

- g) Une comité des citations doit être formé. Ce comité aura la responsabilité de recommander des candidats susceptibles de se voir décerner une citation par la Société, et il réévaluera chaque année les critères utilisés pour l'attribution de ces citations.

ii A new By-Law be added to read

By-Law 15 Citations

- a) The Society may award citations to individuals or groups who in the opinion of Council have, in the previous year, made some outstanding contribution in helping to alleviate pollution problems, in promoting environmental improvements, or in developing environmental ethics.
- a) La Société peut décerner des citations à des individus ou à des groupes qui, à son opinion, ont apporté, dans l'année qui précède, une contribution exceptionnelle à la solution des problèmes de pollution, à l'amélioration de l'environnement, ou au développement d'une "éthique" écologique.
- b) All citations shall be made by Council after receiving the recommendations of the Citations Committee.
- b) Toutes les citations seront attribuées par le Conseil d'administration, sur recommandation du comité des citations.
- c) Nominations for the award of citations from members and Centres will be called for by the Corresponding Secretary in an appropriate issue of Atmosphere each year, with March 1 as the deadline for receipt of nominations. Nominations received by this date will be forwarded to the Citations Committee for their consideration.
- c) Le secrétaire-correspondant se chargera de recueillir les nominations des membres et des centres locaux, après en avoir fait l'annonce officielle dans la revue Atmosphère, chaque année; la date du 1 mars marque la fin des mises en nomination. Toutes les nominations recueillies par le secrétaire-correspondant avant cette date seront alors remises au comité des citations afin qu'il puisse les prendre en considération.

REPORT OF NOMINATING COMMITTEE

The following names are submitted in nomination for Council for the year 1975-76. All nominees have been contacted and have given their consent to accept the office if elected.

President	P. E. Merilees
Vice-President	J. Hay
Past President	A. J. Robert
Corresponding Secretary	H. G. Leighton
Recording Secretary	P. Zwack
Treasurer	R. Gagnon
Councillors-at-large	D. O'Neil R. M. Gagnon D. B. Fraser
Auditor	R. D. Easto

INFORMATION FOR AUTHORS

Editorial policy. *Atmosphere* is a medium for the publication of the results of original research, survey articles, essays and book reviews in all fields of atmospheric science. It is published quarterly by the CMS with the aid of a grant from the Canadian Government. Articles may be in either English or French. Contributors need not be members of the CMS nor need they be Canadian; foreign contributions are welcomed. All contributions will be subject to a critical review before acceptance. Because of space limitations articles should not exceed 16 printed pages and preferably should be shorter.

Manuscripts should be submitted to: the Editor, *Atmosphere*, West Isle Office Tower, 5th Floor, 2121 Trans-Canada Highway, Dorval, Quebec H9P 1J3. Three copies should be submitted, typewritten with double spacing and wide margins. Heading and sub-headings should be clearly designated. A concise, relevant and substantial abstract is required.

Tables should be prepared on separate sheets, each with concise headings.

Figures should be provided in the form of three copies of an original which should be retained by the author for later revision if required. A list of legends should be typed separately. Labelling should be made in generous size so that characters after reduction are easy to read. Line drawings should be drafted with India ink at least twice the final size on white paper or tracing cloth. Photographs (halftones) should be glossy prints at least twice the final size.

Units. The International System (SI) of metric units is preferred. Units should be abbreviated only if accompanied by numerals, e.g., '10 m', but 'several metres.'

Footnotes to the text should be avoided.

Literature citations should be indicated in the text by author and date. The list of references should be arranged alphabetically by author, and chronologically for each author, if necessary.

RENSEIGNEMENTS POUR LES AUTEURS

Politique éditoriale. *Atmosphère* est un organe de publication de résultats de recherche originale d'articles sommaires, d'essais et de critiques dans n'importe lequel domaine des sciences de l'atmosphère. Il est publié par la SMC à l'aide d'une subvention accordée par le gouvernement canadien. Les articles peuvent être en anglais ou en français. Il n'est pas nécessaire que les auteurs soient membre de la SMC; les contributions étrangères sont bien-venues. A cause des limitations d'espace les articles ne doivent pas dépasser 16 pages dans le format final. Tout article sera soumis à une critique indépendant avant d'être accepté.

Les manuscrits doivent être envoyés à : le Rédacteur, *Atmosphère*, West Isle Office Tower, 5e étage, 2121 route Trans-canadienne, Dorval, Québec H9P 1J3. Ils doivent être soumis en trois exemplaires dactylographiés à double interlignes avec de larges marges. Les titres et sous-titres doivent être clairement indiqués. Chaque article doit comporter un résumé qui soit concis, pertinent et substantiel.

Les tableaux doivent être préparés et présentés séparément accompagnés d'un titre et d'un numéro explicatifs concis.

Les graphiques doivent être présentés en trois copies dont les originaux devraient être conservés par l'auteur au cas où ils seraient nécessaire de les reviser. Une liste des légendes des graphiques doit être dactylographiée séparément. L'étiquetage doit être de grand format de façon à ce qu'il soit facilement lisible après réduction du format. Le traçage des lignes doit s'effectuer au moyen d'encre de chine en doublant, au moins, le format final, le tout sur papier blanc ou sur papier à calquer et identifié adéquatement. Les photographies (demi-teintes) devraient être présentées sur épreuves glacées au double du format final.

Les unités. Le Système International (SI) d'unités métriques est préférable. Les unités devraient être abrégées seulement lorsqu'elles sont accompagnées de nombres, ex: "10m", mais "plusieurs mètres".

Les notes de renvoi au texte doivent être évitées.

Les citations littéraires doivent être indiquées dans le texte selon l'auteur et la date. La liste des références doit être présentée dans l'ordre alphabétique, par auteur et, si nécessaire, dans l'ordre chronologique pour chaque auteur.

The Canadian Meteorological Society came into being on January 1, 1967, replacing the Canadian Branch of the Royal Meteorological Society, which had been established in 1940. The Society exists for the advancement of Meteorology, and membership is open to persons and organizations having an interest in Meteorology. At nine local centres of the Society, meetings are held on subjects of meteorological interest. *Atmosphere* as the scientific journal of the CMS is distributed free to all members. Each spring an annual congress is convened to serve as the National Meteorological Congress.

Correspondence regarding Society affairs should be directed to the Corresponding Secretary, Canadian Meteorological Society, c/o Dept. of Meteorology, McGill University, P.O. Box 6070, Montreal, P.Q. H3C 3G1

There are three types of membership - Member, Student Member and Sustaining Member. For 1975 the dues are \$20.00, \$5.00 and \$50.00 (min.), respectively. The annual Institutional subscription rate for *Atmosphere* is \$15.00

Correspondence relating to CMS membership or to institutional subscriptions should be directed to the University of Toronto Press, Journals Department, 5201 Dufferin St., Downsview, Ontario, Canada, M3H 5Y8. Cheques should be made payable to the University of Toronto Press.

La Société météorologique du Canada a été fondée le 1^{er} janvier 1967, en remplacement de la Division canadienne de la Société royale de météorologie, établie en 1940. Cette société existe pour le progrès de la météorologie et toute personne ou organisation qui s'intéresse à la météorologie peut en faire partie. Aux neuf centres locaux de la Société, on peut y faire des conférences sur divers sujets d'intérêt météorologique. *Atmosphere*, la revue scientifique de la SMC, est distribuée gratuitement à tous les membres. À chaque printemps, la Société organise un congrès qui sert de Congrès national de météorologie.

Toute correspondance concernant les activités de la Société devrait être adressée au Secrétaire-correspondant, Société météorologique du Canada, Département de Météorologie, l'Université McGill, C.P. 6070, Montréal, P.Q. H3C 3G1

Il y a trois types de membres: Membre, Membre-étudiant, et Membre de soutien. La cotisation est, pour 1975, de \$20.00, \$5.00 et \$50.00 (min.) respectivement. Les Institutions peuvent souscrire à *Atmosphere* au coût de \$15.00 par année.

La correspondance concernant les souscriptions au SMC ou les souscriptions des institutions doit être envoyée aux Presses de l'Université de Toronto, Département des périodiques, 5201 Dufferin St., Downsview, Ontario, Canada, M3H 5T8. Les chèques doivent être payables aux Presses de l'Université de Toronto.

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ATMOSPHERE

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