

NATIONAL METEOROLOGICAL CONGRESS

Université de Sherbrooke
Sherbrooke, Qué.

June 8 - 10, 1966

PROGRAMME

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SESSION ONE

June 8, 1966

9:00 - 12:00 AM

GENERAL SESSION

Chairman: A. W. Brewer,
University of Toronto,
Toronto, Ont.

OPENING ADDRESS

G. D. Robinson
Meteorological Office, Bracknell, England
President, Royal Meteorological Society
(60 min.)

PARTICULATE PUFF DIFFUSION

M.G. Dudley, E. E. Howlett and E. R. Walker
Suffield Experimental Station,
Ralston, Alberta.

In a short series of diffusion experiments recently concluded at Suffield Experimental Station, two sizes of small glass spheres were simultaneously released from a puff source at a height of 7.8 metres.- The spheres were caught on ground level samplers arrayed on arcs at distances up to 270 metres. The experimental procedures are briefly described and aspects of the results discussed.

The standard deviations of cross-arc deposits were proportional to distance downwind of the source. These standard deviations were fairly well predicted by the expanding puff techniques of Smith and Hay. The predictions were improved by using a most appropriate value of " β ", a Lagrangian-Eulerian scale factor.

The problem of choosing an appropriate transport wind tended to reduce the accuracy of prediction of the downwind pattern of crosswind-integrated deposit.

3 MEAN CONCENTRATION PROFILES AND DISTANCE
NEIGHBOUR FUNCTIONS IN RELATIVE DIFFUSION

G. T. Csanady
University of Waterloo, Waterloo, Ont.

Experimental data on relative diffusion (such as those collected in the course of dye-plume studies on Lake Huron) may be analyzed to yield mean concentration distributions about the centre of gravity and also "distance-neighbour functions", as suggested by L. F. Richardson. Tentative theoretical results on the latter function have been derived by Richardson and Batchelor, while a vague application of the central limit theorem suggests a Gaussian distribution of the mean concentration about the centre of gravity.

Data collected during the 1965 season show that the mean concentration distribution is indeed Gaussian. Measured distance-neighbour functions, however, do not agree with either the Richardson or the Batchelor curves, but are intermediate between the two. Data on mean square concentration fluctuations show trends known from laboratory measurements and theoretical analyses.

SESSION TWO

June 8, 1966

1:30 - 4:30 PM

MESOMETEOROLOGY

Chairman: W. F. Hitschfeld,
McGill University,
Montreal, Qué.

1 DÔMES DE PRESSION ET PRECIPITATION

C. East

Collège Jean-de-Brébeuf, Montréal, Qué.

(15 min.)

Grâce à un radar et à un réseau à moyenne échelle de 45 micro-barographes, on a confirmé en Alberta central que les dômes de pression sont généralement associés à de la précipitation de caractère convectif. Les échos de radar ne sont pas toutefois nécessairement situés au centre de ces dômes; de plus, alors que les échos se meuvent ordinairement en phase avec le dôme de pression, ils perdent peu à peu du terrain lorsqu'ils entrent dans leur stage de dissipation. Dans aucun cas a-t-on pu observer la formation d'un dôme de pression faisant suite à l'apparition récente d'échos de radar; mais souvent on a pu remarquer que le développement d'un dôme de pression survenait en même temps ou immédiatement après un développement similaire des échos de radar. Des mesures de la masse d'air en excès et de l'aire couverte par les échos suggèrent que le développement des dômes de pression survient 15 à 30 minutes après l'augmentation correspondante de la surface couverte par les échos.

By means of a radar and a mesoscale network of 45 microbarographs set up in central Alberta, pressure domes (meso highs) were confirmed to be generally associated with convective precipitation. Radar echoes, however, do not lie necessarily in the centre of the dome; and, while they generally move in phase with the dome, they lag progressively behind as they enter a stage of dissipation. Although no formation of a pressure dome could be observed following the formation of radar echoes, an expansion of the dome and an increase in its amplitude

was often observed to occur concurrent with, or immediately following, an increase in the echo area. Measurements of the excess mass and of the echo area suggested a 15- to 30-minute lag of excess mass generation with respect to the increase in the echo area.

2 FREQUENCY OF SOFT HAIL IN CENTRAL ALBERTA

P. W. Summers

Research Council of Alberta, Edmonton, Alta.

(15 min.)

Although soft or slushy hail has been reported at various times in several parts of the world little quantitative data is available on the frequency of occurrence. Its occurrence is of interest both from the point of view of hail growth theories and the practical aspects of hail suppression. A question regarding soft hail was therefore added to the hail report cards used by the Alberta Hail Studies project in 1965. A total of 3242 farmers in central Alberta answered the question during the summer, and these answers are analysed.

Thirty-nine percent of the farmers observed some soft hail. There was a marked seasonal variation with a maximum frequency of occurrence in May (53%) and September (66%), and minimum in July (31%). Soft hail was more often associated with large hail in May and September, but with small hail in June, July and August. When soft hail was reported it was nearly always estimated to be the largest stones falling at that point that were soft.

Individual storms showed three distinct types of frequency distribution of soft hail versus associated largest size. Also the spacial distribution of the location of soft hail reports within individual hail swaths shows evidence of distinctive patterns. These patterns should be studied further and fitted into models of hailstorm dynamics, and may give additional clues on the cloud moisture environment in which the stones grow.

VARIATION OF A LAKE BREEZE WIND WITH TIME NEAR THE LAKESHORE

W. J. Moroz

University of Toronto, Toronto, Ont.

(15 min.)

A series of observations of the local lake breeze thermal circulation has been made using pilot balloons at a location on the eastern shore of Lake Michigan under circumstances where external factors influencing the development of the local wind system were minimal. The variations of the across shore and along shore components of the wind with time are presented for several levels above an observation site at the lake shore. A lake breeze return current above the layer of on shore flow is clearly evident in the data. The layer of return flow is deeper than that of the lake breeze and velocities in the return current are lower than those in the layer of on shore flow. Turning of the lake breeze wind with time in response to Coriolis forces is apparent in the observations presented. The existence of a simultaneous lake breeze blowing in opposite directions on opposite sides of the lake is also demonstrated using climatological records.

4 AN APPROACH TO SHORT-RANGE FORECASTING

J. Clodman

Meteorological Service of Canada, Toronto, Ont.

(15 min.)

The three common approaches to forecasting, namely by physical equations (N. W. P.), by subjective application of physical and statistical information, and by conventional statistical techniques are examined briefly and their short-comings noted. The possibility of a methodology which would include the advantages of each is considered. Such a methodology should permit incorporation of results from N. W. P. and related methods as they become available; it should avoid the deficiencies in regard to memory and inconsistent application associated with a subjective approach; and it should not be restricted to the simple models and parametric assumptions of conventional statistics. A first attempt at such an approach as applied to short-range forecasting is indicated and the difficulties and problems described. The future of such a concept is considered.

F. B. Muller

Meteorological Service of Canada, Toronto, Ont.

(15 min.)

All local area forecast studies based upon the regular surface and upper air observations from a group of ten or fifteen stations may now be carried out automatically, using all the data accumulated in the last 15 to 20 years as input to an operating computer programme system whose general nature is described.

The system allows for the evaluation or inclusion, on an hour to hour basis, of parameters of large scale as well as of local and meso-scale.

The system is designed as a research tool for study of local weather and its relation to larger scales, but has implications with regard to automation of certain aspects of local and short range forecasting. In particular it allows for the complete evaluation of any local forecast procedure to the extent permitted by historical data.

SESSION THREE

Section I

June 9, 1966

9:00 - 12:00 AM

DYNAMIC METEOROLOGY AND NUMERICAL WEATHER PREDICTION

Chairman: A. Thomson
Toronto, Ont.

1 A SMOOTHING SYSTEM DESIGNED FOR USE IN OBJECTIVE ANALYSIS

R. Asselin and H. B. Kruger

Meteorological Service of Canada, Montreal, Qué.

Unsmoothed objective analyses produced by computer schemes of the successive approximations type tend to fit station data closely, but contain unrepresentative wave components in regions of trial field inadequacy and low data density. These components, noted subjectively as analysis errors between stations, are due to deficiencies in the analysis technique. Application of conventional smoothing operators, while resulting in the removal of many undesirable features and in improvement of the between-station analysis, tend to lead to deterioration of the on-station analysis and in amplitude reduction of data-established smaller scale features.

This problem was commented on in 1962 by Thomassel and James of Travelers Research Center, Inc. They suggested that the data distribution density, specified at each grid point for the region around it, be used to control the amount of smoothing at each point in "the expectation that smoothing of small scale features is of more importance in sparse data regions than in dense data regions where such features might be better delineated". The smoothing operator which they proposed, however, had the major deficiency of poor wavelength selectivity.

An analysis-orientated smoothing system is described which utilizes a field of accumulated values of distance-weighting parameters. This field, which is a by-product of the CAO objective analysis scheme, facilitates the grouping of the grid point values of the analysis into several classes of data representativeness. A special filter is designed for each class to eliminate only those wavelengths which are unlikely to be definable by the range of data representativeness applicable to the class. The appropriate class filter is applied at each of the grid points of the analysis; the result is a further improvement of the between-station analysis, a closer fit to the station reports and a better definition of smaller scale features.

The analysis process and the comparative effects of different smoothing schemes are displayed in a series of one-dimensional cases. An actual analysis, unsmoothed, conventionally smoothed, and smoothed with the system described, illustrates the two-dimensional effects.

2 LATENT HEAT EFFECTS IN NUMERICAL PRECIPITATION MODELS

R. Daley

McGill University, Montreal, Qué.

(15 min.)

A two-level geostrophic baroclinic model is created to calculate vertical motions and rainfall rates over the whole of North America.

The effect of the latent heat of condensation on the vertical motion is accounted for by using as a thermodynamic equation the conservation of potential wet bulb temperature. In the resulting thickness tendency equation, a moist stability parameter is defined which is calculated explicitly for every point on the grid and used in the " ω " equation when conditions of moisture and upward vertical motion warrant it. Corrections are also made for time-to-saturation and cloud storage.

The model includes the latest advances in determining the orographical and frictional influences, particularly in their application at height of terrain rather than at mean sea-level.

There is also an attempt at incorporating a variable level of non-divergence.

Five cases were studied - four in winter and one in early spring. The calculated rainfall patterns were found to compare favourably with reality. Tentative conclusions are that the release of latent heat can increase motion by a factor of 2-3 depending upon the scale and configuration of saturated regions.

3 NUMERICAL FORECASTS OF QUANTITATIVE
 PRECIPITATION BASED ON THE CAO
 BAROCLINIC MODEL

D. Davies

Meteorological Service of Canada, Montreal, Qué.

(15 min.)

Hourly forecasts of precipitation amount are computed for three-layer and one-layer models of the atmosphere over a 1005 point grid.

In theory the scientific technique is quite a straightforward one in which the vertical motion is computed from the thermodynamic equation, including a latent heat term, and the temperature and dew point depression forecasts are obtained from the standard mathematical expansions of the appropriate total time derivatives.

In practice four technical problems arise which have to be overcome in order to prevent computational instability.

Objective verifications, based on objective analyses of reported precipitation amounts, indicate that the three-layer forecasts are slightly better than the one-layer forecasts. First attempts to include rudimentary small scale effects, although not unpromising, usually led to a deterioration in the quality of the forecasts.

4 THE TROPOSPHERIC -STRATOSPHERIC
RELATIONS PROJECT

K. D. Gardner

Meteorological Service of Canada, Halifax, N. S.

(15 min.)

This report summarizes the results of a statistical study of relationships between the troposphere and the stratosphere as a function of scale, using six months of daily height data from the 50 and 30 mb surfaces. The techniques of cross-spectral analysis, which form the basis of this study, are examined critically, and the problem of the interpretation of cross-spectra is discussed.

The strongest statistical relationships were found to exist for planetary-scale waves and fluctuations in amplitude whose period was nine days or longer; the relationship is strongest at about 50°N. No consistent relationships were found for fluctuations of other space and time scales or for zonal parameters.

The phase data indicate a slight tropospheric lead on most time scales where the coherence is significant. However, a stratospheric lead was evident at a period of thirty-six days; examination of the original data suggested that the dramatic sudden warming during the period under study had significantly affected the flow at the 500 mb level.

Comparison of these results with those obtained directly from energy balance studies (Julian and Labitzke, 1965) highlight the usefulness of cross-spectral analysis as a diagnostic tool in the study of meteorological relationships.

All of the original data and the final results are presented in the appendices.

EXPERIMENTS IN OBJECTIVE FRONTAL
CONTOUR ANALYSIS

W.S. Creswick

Meteorological Service of Canada, Montreal, Qué.

(15 min.)

Following the method of Clarke and Renard, experiments were carried out to determine the feasibility of objective analysis of upper level fronts. Parameters used were wet-bulb potential temperature, layer thickness, and geostrophic wind shear as determined from objectively analyzed fields of height, temperature and dew point at 850, 700 and 500 mb levels. Attempts were made to duplicate subjective analyses by arbitrarily weighting these parameters, but marked differences remained, partly because of the rather coarse grid used in finite differencing, but also because of considerable variation in frontal intensity with height. The objective fronts generally show a marked increase of wet-bulb potential temperature with height. This was further investigated by examining frequency distributions of wet-bulb potential temperature in constant pressure surfaces, in which fronts appear as frequency minima.

SESSION THREE

Section II

June 9, 1966

9:00 - 12:00 AM

ATMOSPHERIC DIFFUSION

Chairman: R. E. Munn
Meteorological Service of Canada
Toronto, Ont.

1 FALL OUT OF DUST FROM A HOT SMOKE PLUME IN THE ATMOSPHERE

C. Rajasekaramurthy
University of Waterloo, Waterloo, Ont.
(15 min.)

A great amount of work has been done separately on the rise of hot gaseous plumes and on the dispersion of dust particles. It is clear, however, that the two problems are related, as most major sources discharge dust laden effluents at considerably higher temperature than the surrounding atmospheric air. Due to the upward momentum and the buoyancy of the emitted effluents, the dust plume is carried up along with the hot plume to a considerable height. At some distance downwind from the stack, due to its free fall velocity, the dust plume effectively separates from the hot plume.

Combining existing knowledge on hot plume behaviour and dust particle diffusion some theoretical estimates of heavy particle movement in hot plumes may be made. The results of such calculations (carried out with the aid of the University of Waterloo's extensive computer facilities) are presented in the form of a number of diagrams.

A PROGRAMME FOR THE SIMULATED DIFFUSION OF SMALL PARTICLES

J. A. McCallum

Suffield Experimental Station, Ralston, Alberta

(15 min.)

A Monte Carlo programme is given for simulating the motion of small particles in a turbulent air flow. By considering a large number of particles it is possible to obtain a representation of the dispersion pattern. The patterns produced by using statistics of turbulence obtained during diffusion trials at Suffield Experimental Station are compared with the actual measured deposits and, in particular, with the predictions of mathematical models. The relative effects of variation of parameters is shown. Several future extensions are indicated.

3 ATMOSPHERIC DIFFUSION OF HEAVY PARTICLES FROM AN ELEVATED CONTINUOUS SOURCE

R. E. Stewart

University of Waterloo, Waterloo, Ont.

(15 min.)

Two dustfall experiments were conducted at Suffield Experimental Station to estimate ground-level deposition pattern. For each experiment two batches of glass microspheres were simultaneously released into the atmosphere from an elevated continuous source. Nominal 50 micron and 100 micron beads were emitted at the 100 foot level for the first experiment and nominal 100 micron and 200 micron beads were emitted at 303 feet for the second experiment. Samplers were placed at ground-level along arcs located at distances ranging between 183 meters and 3621 meters from the stack. Measurements of wind speeds and gustiness were made at various levels on the 300 foot tower.

It was found that the deposition pattern could be predicted reasonably well by theory using linear-growth relationships for the plume standard deviations. This same behaviour was observed in earlier experiments with shorter stacks.

The presence of a "crossing trajectories effect" is not apparent from the plume data on lateral spread. An equation estimating this effect is derived in the report.

4 FREQUENCY OF OCCURRENCES OF MAXIMUM
 POLLUTION LEVELS FROM SINGLE STACKS

P. J. Barry

Atomic Energy of Canada Limited, Chalk River, Ont.

(15 min.)

A radioactive noble gas, argon-41, is discharged continuously from the CRNL stack at an almost constant rate. The concentration of the gas at ground level has been measured continuously at five sampling stations at various distances around the stack. The magnitude of maximum pollution levels occurring in the vicinity and also the frequency with which maximum levels of different magnitudes occur have been estimated from the results. The occurrence of maximum pollution levels is related to such meteorological variables as atmospheric stability and wind turbulence.

5 SOME OBSERVATIONS ON THE RISE OF HOT
 PLUMES FROM A LARGE INDUSTRIAL STACK

P. R. Slawson

University of Waterloo, Waterloo, Ont.

(15 min.)

Careful plume rise observations by photographic means have been made on smoke plumes from the Lakeview Generating Station (Ontario) and compared with some existing theoretical formulae. Supporting data, in considerable detail on stack parameters were available.

A linear section of the plume was found to exist beyond a specific transition point in a neutral atmosphere. Also, the

previously established simple power law $Z \propto F^{1/3} U^{-1} X^{2/3}$, agreed quite well with observation within the limitations of the photographic technique.

In a dynamically unstable atmosphere the plume was sometimes above and sometimes below a corresponding plume in neutral conditions, under the opposing influences of increased dilution and the direct effect of instability in promoting plume rise.

SESSION FOUR

June 10, 1966

9:00 - 12:00 AM

PHYSICAL METEOROLOGY

Chairman: D. P. McIntyre,
Meteorological Service of Canada,
Toronto, Ont.

1 ON THE EMISSIVITY OF CLOUDS

J. R. Allen and W. F. Hitschfeld
McGill University, Montreal, Qué.

(15 min.)

Computations have been carried out to establish the feasibility of determining the long-wave emissivity of clouds by measuring the radiant flux at the ground. The spectral band is limited to the atmospheric window (8 - 13 μ) in order to limit the effect of the intervening atmosphere. The parameters considered in the computations are the amounts and distributions of ozone, water vapour and carbon dioxide in the atmosphere, and the height, emissivity and reflectivity of the cloud base. It is concluded that the available data on ozone, water vapour and carbon dioxide enable the effect of the intervening atmosphere to be computed to a sufficient degree of accuracy. The effects of emissivity and reflectivity cannot be separated with a single measurement but, since reflectivity is known to be small, it is anticipated that it should be possible to determine emissivities to within 15%.

Measurements of the downward flux in the atmospheric window, arriving at the surface within an angle of 1° from zenith are being made. Results so far indicate the qualitative validity of the calculations.

ENVIRONMENTAL ERRORS IN THE USE OF THE AIRBORNE RADIATION THERMOMETER

R. W. Shaw

University of Toronto, Toronto, Ont.

(15 min.)

The Airborne Radiation Thermometer (ART), used to measure synoptically the surface temperature of a lake, indicates an apparent black body radiation temperature at the aircraft flight level. Therefore a correction must be made for absorption and emission by atmospheric gases, as well as the emissivity of the water surface.

Data for the study were obtained from a test and evaluation programme conducted by the Lakes Investigation Unit of the Meteorological Branch. This consisted of five flights of a Lockheed 14 aircraft over the research vessel C. C. G. S. "Porte Dauphine". ART temperature readings were recorded at different flight altitudes while simultaneous ship bucket temperatures were taken. A vertical sounding of temperature and humidity in the lowest 1000 feet was obtained by the ship's tethered-sonde facility.

A layered model of the atmosphere is developed, and a programme written for the IBM 7094 computer calculates the radiation arriving at the ART sensing head from the various radiating sources. These are the water vapour and carbon dioxide in the atmosphere which the ART sees both directly and by reflection from the water surface, and a cloud deck (if present) above the aircraft which is seen by reflection. Since the total incoming energy is known from the measured black body temperature, the only unknown component, the radiation from the lake, can be found. An iterative process then computes the lake surface temperature.

Use of the programme under widely varying meteorological conditions from May, 1965 to January, 1966 showed that an improved estimate of lake temperature could be obtained in almost all cases. The calculated radiation from the atmosphere below the aircraft was the most important non-lake radiation source, and consequently the temperature and humidity distribution beneath the aircraft must be fairly well known if a correction is to be made. This is particularly true at low altitudes under pronounced inversion on superadiabatic conditions. It was also found

that the radiation seen by reflection could not be ignored, especially under overcast skies.

3

ON THE RELATIONSHIP BETWEEN THE
VARIATIONS OF VERTICAL OZONE
DISTRIBUTION AND THE TOTAL OZONE AMOUNT

R. D. Bojkov

University of Sofia, Sofia, Bulgaria

(15 min.)

The study is carried out on the basis of about 3500 individual vertical ozone profiles taken at a few stations. The atmosphere between the ground and 50 km is divided into 7 layers. The calculated correlation coefficients between the departures from their respective mean value of total ozone and the ozone in the successive layers show:

The relationship between the simultaneous changes of total ozone amount and the partial ozone content from 0 to 24-28 km is positive; above 24-28 km it is very weak or negative. The correlation coefficients are most significant in the lower and beginning of middle stratosphere (10 to 24-28 km) where they have a value $> 0.75 \pm 0.05$. Approximately half as much are correlation coefficients with the tropospheric ozone. Above 24-28 km they are smaller and negative values dominate during the autumn season.

The comparison of the values of the correlation coefficients of a few stations on different latitudes gives the possibility of finding out a latitudinal effect in the relationship between the variations of vertical ozone distribution and total ozone. The values of correlation coefficients become greater with height toward the equator. The correlation coefficients have values > 0.55 up to the top layer at the tropical latitudes. This is considered due to dependence on the photochemical reactions which are more significant at lower latitudes. The higher troposphere in the tropics has a lower value of the correlation coefficients up to 15 km.

There are discussed a few results of the correlation between the changes of partial ozone content in different layers. They show a positive relationship between the amounts in the lower and middle stratosphere. However, the relationship between amounts in the upper stratosphere and those at lower levels is weak or negative.

All results substantiate that the changes in total ozone amount are closely connected to the variation of the ozone content of the region between 10 and 24 km.

4 DIABATIC HEATING RATES IN THE STRATOSPHERE

G. Paulin

McGill University, Montreal, Qué.

(15 min.)

Stratospheric diabatic heating rates due to absorption of ozone in the ultraviolet, water vapour, carbon dioxide and ozone in the infrared domain have been computed for three days in May 1963 over seven stations of North America: Thule, Churchill, Goose Bay, Bedford, Fort Collins, Albuquerque and Tallahassee. The specific levels of interest were between 245 mb and 12 mb. Ozone data were gathered from published ozone-sonde reports. Carbon dioxide was considered as mixed in a constant ratio. Water vapour data were taken from radiosonde reports in the troposphere, and a constant relative humidity of 2% was assumed in the stratosphere.

A numerical model was devised to compute the heating rates in the stratosphere. The net results show the major influence of carbon dioxide with a variable but significant effect of ozone mostly through its variable vertical profile. The heating rates at the highest reliable level of the model, i. e. 20 mb, are found to vary from about 0.5 to 1.0 degrees C per day, being negative and being largest in the absolute sense, over the northern stations. The corrective effects of the diabatic heating upon the vertical velocities computed from the so-called "adiabatic method" are found to vary from about 0.05 to 0.1 cm/sec at the highest level, and decreasing with height.

THE ICE NUCLEATION BEHAVIOUR OF
AMINO ACID PARTICLES

J. Maybank

Saskatchewan Research Council, Saskatoon
and

N. Barthakur

University of Saskatchewan, Saskatoon

The problem of whether ice nucleation takes place more readily from the vapour directly to the solid, or via an intermediate liquid phase has been studied for several of the more efficient amino acid nucleators. It has been shown that the threshold temperatures observed in cloud chamber tests are in fact those of the material acting as freezing nuclei (i. e. via the liquid phase), and any discrepancies between such tests and trials with bulk water may be accounted for satisfactorily by partial destruction of the nucleus surface by the water. Investigations on ice formation about airborne particles and on macroscopic amino acid crystals has shown that for certain of these substances a transition in behaviour takes place around -20°C . Below this temperature ice formation no longer requires saturation conditions with respect to supercooled water and so the particles may be considered to act by converting the vapour directly to ice, thereby designating them as sublimation nuclei.

The major obstacle in the way of airborne particles acting as freezing nuclei has been the requirement that they act first as condensation centres. Under the conditions prevailing in supercooled clouds with vapour pressures equal to, or barely exceeding that, of water saturation, condensation is unlikely on the somewhat hydrophobic surfaces of amino acid particles. It has been shown, however, by using a radioactive tracer in small water droplets that droplet-particle collisions can occur. While not efficient, this process would permit a few particles in a cloud chamber experiment to act as freezing nuclei, thereby establishing the potential activity of the material itself.

SESSION FIVE

June 10, 1966

1:30 - 4:30 PM

MICROMETEOROLOGY

Chairman: R. W. Longley,
University of Alberta,
Edmonton, Alberta.

1 MICROMETEOROLOGICAL TOWER OBSERVATIONS FROM MONTREAL, OTTAWA AND SARNIA

R. E. Munn

Meteorological Service of Canada, Toronto, Ont.

Average values of temperature difference and wind by hour of the day and month of the year are presented for three 200-ft towers: in Montreal (built-up area), Ottawa (suburban exposure) and Sarnia (rural environment). Inversion intensities are greatest in Sarnia and smallest in Montreal, as a result of the urban heat island effect.

Richardson numbers have been calculated; the daily and seasonal cycles are quite similar to those of temperature difference, although displaying much more scatter. Both Ri and temperature difference are indices of turbulence but must be used in conjunction with wind speed.

The best location for a tower depends on local topography as well as upon the uses to be made of the data. In the absence of lakes or valleys, there is little to choose between a country or an urban site; however, the analyst must be aware of the fact that the country tower will at times be within the urban heat island when winds are blowing from the city.

2 DISTRIBUTION OF TEMPERATURE AND HUMIDITY
 WITHIN TURBULENCE NEAR THE GROUND

D. R. Hay and H. C. Martin

University of Western Ontario, London, Ont.

(15 min.)

The fluctuations of temperature and humidity in the air above an outdoor grassy field have been observed with a new refractivity-temperature instrument. The spectrum of scale sizes examined extended from 50 cm. to 2 meters. Both the humidity and temperature spectra in this range conform with Kilmogoroff's hypothesis of isotropic turbulence, but simultaneity and correlation between the fluctuations of these quantities decrease with decreasing scale size. Organized structures superimposed upon the turbulent background are interpreted as convective plumes, and within these the humidity boundaries are more diffuse than the temperature boundaries.

3 TURBULENT HEAT FLUXES IN A FOREST

G. A. McBean

McGill University, Montreal, Qué.

(15 min.)

Investigations have shown that although the mean wind in a forest is small there is still considerable turbulent heat exchange. In this study a fast response vertical anemometer and wet and dry bulb thermocouples were used to measure the turbulence within a forest canopy. Five trials of ten minutes duration were run in a fourteen foot high lodgepole pine forest in the Marmot Creek basin on August 21, 1965.

The data were extracted from chart recordings at one second intervals and analyzed on a digital computer.

The results indicate that the level of turbulence was as high as over open ground. The spectra and cross spectra of vertical wind, temperature, and specific humidity were calculated. For four day-time trials the characteristic time scales were four

seconds for the vertical wind fluctuations and approximately fifteen seconds for the temperature and humidity fluctuations. At night time the time scales of temperature and humidity were much shorter. The wind fluctuations were very intermittent and no meaningful results could be obtained.

The fluxes of sensible and latent heat were calculated by the eddy correlation method. The heat fluxes were small, being of the order of 0.05 ly/min, and did not balance with the net radiation measured at the same level. The latent heat flux was in all cases the smaller flux and was usually negative.

4

SOME STUDIES OF SENSIBLE AND
LATENT HEAT FLUXES AT WALTAIR,
SOUTHEASTERN COAST OF INDIA.

R. J. Polavarapu

Meteorological Service of Canada, Toronto, Ont.

(15 min.)

Sensible and latent heat fluxes were estimated at Waltair (latitude $17^{\circ} 42' N$, longitude $83^{\circ} 18' E$) by different methods for a period of 22 months from profile measurements of temperature, wind and humidity. The validity of these methods was assessed by comparing the annual totals of sensible and latent heat fluxes with those of net radiation, neglecting the heat-flow into the soil. Diurnal and seasonal variations of the sensible and latent heat fluxes are discussed. The apportioning of available energy (net radiation) between the latent and sensible heat depends mainly on the moisture condition of the soil and to a smaller extent on the moisture content of the air layers above, considering periods that the heat-flow into the soil may be neglected. During the monsoon and postmonsoon periods (wet ground), the latent heat flux was higher than the sensible heat flux and the reverse conditions prevailed during the other periods, winter and summer.

A relation between Bowen's ratio and the mean moisture content of the top 30 cm of the soil layer was obtained. Evapotranspiration may be estimated from such relations knowing the moisture content of the soil and the net radiation.

THE WIND PROFILE

P. J. Barry

Atomic Energy of Canada Limited, Chalk River, Ont.

(15 min.)

It is generally agreed that wind profiles obtained in a diabatic atmosphere consistently depart from a logarithmic form. Semiempirical attempts, based on similarity theory, have been made to handle the diabatic profile and relate it to the surface stress.

In this paper, wind profiles obtained in the lowest two metres of the atmosphere have been re-examined. It is shown that, although many cases of non-logarithmic profile do occur, the departures are, within the expected limit of experimental error, far from consistent. Estimates of the surface stress are at least as good and sometimes better than can be obtained from other formulae, (assuming that the logarithmic profile holds irrespective of the thermal stratification). The significance of this is discussed with particular reference to similarity theories.