ISSN 1195-8898

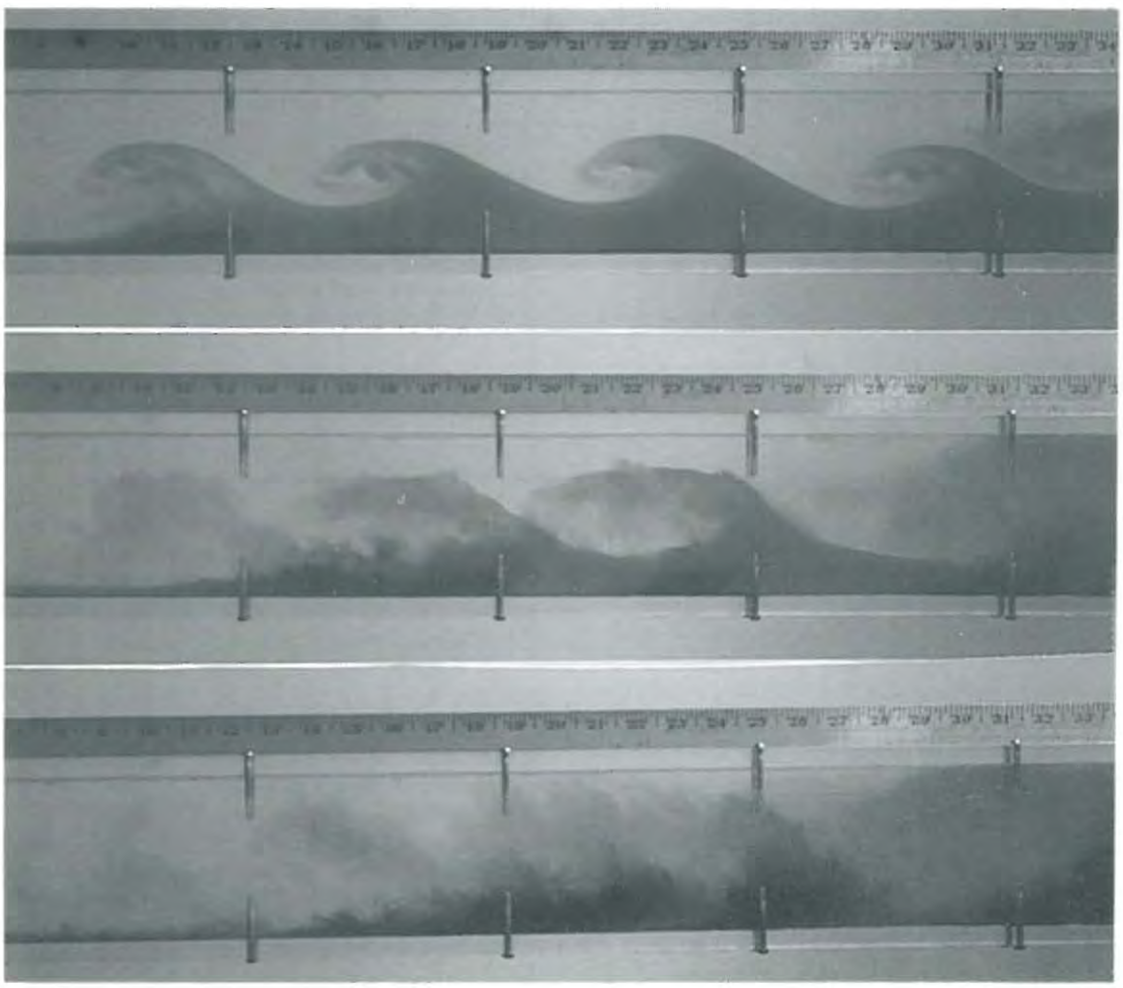
CMOS
BULLETIN
SCMO

Canadian Meteorological and Oceanographic Society

La Société canadienne de météorologie et d'océanographie

December/décembre 1994 Vol. 22 No. 6

Kelvin-Helmholtz Instability



CMOS Bulletin SCMO

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Inside / En bref

PAGE FRONTISPICE: **Instabilité de Kelvin-Helmholtz** représentée ici par une série d'ondes instables en phase avancée de déferlement. Ces ondes ont été créées à l'intérieur d'un réservoir rectangulaire (3x10x182 cm). Deux liquides de masses volumiques différentes, soit de l'eau pure et de l'eau salée et colorée (apparaissant ici en gris), occupent le volume intérieur. En inclinant le réservoire de 8^{o}, on génère un cisaillement entre les deux fluides qui est nécessaire à l'émergence de l'instabilité. La longueur d'onde relativement longue (16.5 cm) des ondes est associée à un gradient vertical de densité réparti sur une épaisseur d'environ 2.5 cm à l'interface des deux liquides. Cette expérience est basée sur celles de S.A. Thorpe (1967-69-70) et fut réalisée par Claude Landry (employé du SEA en congé d'études) et J. Sébastian Fontecilla au laboratoire de science de l'atmosphère de l'Université du Québec à Montréal dans le cadre du cours de maîtrise "Instrumentation et travaux pratiques".

FRONT PAGE: A sequence of unstable waves in the advance overturning mode representing the **Kelvin-Helmholtz Instability**. These waves were created inside a rectangular reservoir (3x10x182 cm). The reservoir was filed with two liquids of different density: pure water and coloured salted water (appearing here in gray). A shear was generated between the two fluids by tilting the reservoir 8^{o}. The resulting wavelength, which is relatively long (16.5 cm), is associated to a vertical density gradient spread over a 2.5 cm thick layer. This laboratory experiment is based on the work of S.A. Thorpe published in 1967-69-70 and was performed at the Atmospheric Sciences Laboratory at the University of Québec at Montréal by Claude Landry (AES employee on educational leave) and J. Sebastian Fontecilla in the graduate course "Instrumentation et travaux pratiques".

EDITOR'S COLUMN

The next issue of the ***BULLETIN*** **23**(1), February 1995, will go to press on February 17th, 1994. Contributions are welcome and should be sent before February 12. We do not have a person for typing nor translating so I need your contribution in a form that can be readily inserted into the Bulletin. The most convenient way is via E-mail to the above address. I accept contributions submitted on floppy disk in standard DOS formats (i.e. WordPerfect (version 4.1 to 5.1), plain ASCII text files, MS Word - at the moment I use Word 6.0 for Windows), however, I can convert Macintosh files to DOS files. If you want to send graphics, then HPGL files can be sent as ASCII files over the networks, any other format will have to be sent on paper or on a floppy disc. It is recommended that whatever software prepares an HPGL file be configured for the HP7550 printer. If you have the option of selecting pen colours, please don't. If you send a file over the network, send a copy to yourself and examine the transmitted copy to check that it is all there. Do you have an interesting photograph, say, an interesting meteorological or oceanographic phenomenon? If so, write a caption and send me a high contrast black and white version for publication in the CMOS Newsletter. Savonius Rotor is still alive for anyone who has an unusual point to make.

Jean-Pierre Blanchet,
CMOS Bulletin Editor

SECTION DU RÉDACTEUR

Le prochain numéro du ***BULLETIN*** **23** (1), février 1995 sera mis sous presse le 17 février '95. Vos contributions sont les bienvenues. Veuillez me les faire parvenir d'ici le 12 février.

Nous ne disposons pas de personnel pour dactylographier ou traduire les textes soumis et je demande votre collaboration en m'envoyant vos textes sous forme électronique (poste internet ou disquette). Les fichiers sur disquettes doivent être dans un format standard DOS (WordPerfect 4.1 ou 5.1, MS Word, texte ASCII). J'emploie actuellement MS Word 6.0 pour Windows. Je peux convertir les fichiers Macintosh équivalents vers DOS. Si vous avez de bonnes photographies pour notre page couverture, s'il vous plaît m'en faire parvenir une copie en noir et blanc bien contrastée avec une légende appropriée.

Jean-Pierre Blanchet,
rédacteur du Bulletin de la SCMO

ARTICLE

Warm Season Ozone Concentration Distribution within the Urban Boundary Layer of Toronto, Ontario According to Air Flow Direction

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ABSTRACT

This article presents the average daytime maximum ozone (O_3) concentrations (O_3max) and nighttime O_3 concentrations (O_3night) within the boundary layer of Toronto, Ontario according to five different air flows during the warm season for the period 1987-1990. It was found that the higher average O_3max were associated with SW and light air flows. The lower average O_3max were associated with NW and NE air flows. Similar results were found for average O_3night. Average O_3max and O_3night were both higher at the CN Tower than at the surface with the gradient in O_3 concentration being larger at night than during the day. The effect on surface O_3max of cloud cover, air temperature and geostrophic speed prevailing along back trajectories are qualitatively assessed. It is speculated that in southern Ontario a synoptic scale stratospheric O_3 contribution may be most noticeable in spring with NW air flows.

1. Introduction and Objectives of Study

In southern Ontario, ground-level ozone (O_3) concentrations have been assessed in the southwest regions neighbouring the United States and mainly at rural and small urban centres (Yap et al., 1988). This article attempts to supplement and provide additional insight into the southern Ontario's O_3 situation by obtaining average O_3 concentrations within the boundary layer of the most populated (over 3 million people) urban centre in Canada, Toronto, according to air flows from four geographical sectors and during air stagnation conditions.

2. Data Analyses Methodology

Ozone concentrations in Toronto are measured at a number of surface sites and at one elevated site located on the Canadian National Telecommunication Tower (CN Tower). Air pollutants monitoring instruments are located on the Tower at a height of 444 m above ground. The Tower is located within the downtown core near the northern shore of Lake Ontario. The surface sites selected for the study are Scarborough, Etobicoke-West and Toronto-West (Figure 1). The sites were selected based on data availability, similar O_3 percentile distributions and because their location provide representative O_3 concentrations within metropolitan Toronto. The concentrations at these three sites were averaged every hour to obtain a surface O_3 concentration for metropolitan Toronto. The O_3 concentrations that were examined are the daytime maximum (O_3max) and the nighttime 0300-0600 EDT average (O_3night). As defined, O_3night should represent a stabilized nighttime concentration. The period of study was the warm season May 15 - September 14 for the years 1987-1990.

Three-day, geostrophic back trajectories were performed to determine the direction from which air flows came. The trajectories were computed (Peterson, 1966) at the 1000 mb level with a 12 hour time step and terminated in Toronto at 2000 and 0800 EDT, in accordance with the time of measurements of meteorological data from upper air stations. The air flows were classified in four sectors centred on Toronto (Figure 2); the sectors were selected to reflect annual emission patterns of anthropogenic O_3 precursors (Figure 2) and climatological air flows. O_3max and O_3night were associated with the 2000 and 0800 EDT back trajectory termination time respectively. A given trajectory was assigned to the sector containing either of: i) the last 36 hours of trajectory path, or ii) at least 48 hours of trajectory path.

Trajectories not meeting either of the above were considered unclassifiable. The average geostrophic speed (U_g) average cloud cover (CC) and average daytime maximum air temperature (Tmax) prevailing along each

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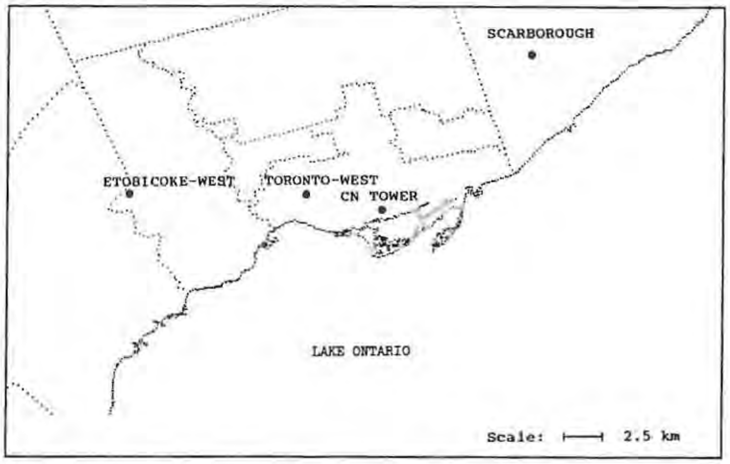

Fig. 1. Map of Metropolitan Toronto indicating the location of the sites selected for the study.

trajectory were also calculated. CC was calculated from the 1200 and 1600 EDT cloud cover for each day of trajectory and Tmax from the 1500 EDT air temperature; CC and Tmax were obtained from weather observing stations within the immediate vicinity of the trajectory path. Trajectories with $U_g \leq 10$ km/hr during at least the last 24 hours prior to termination were classified as light air flow (LAF). O_3 concentrations associated with light air flows may give a general indication of possible O_3 concentrations during air stagnation.

A potential source of error of this analysis is the assignment of the measured O_3max and O_3night to the incorrect sector by using 1000 mb geostrophic trajectories. However, because of the large dimension of the sectors it is expected that the difference in sector-assignment errors between 1000 mb geostrophic trajectories and, for example, 925 mb non-geostrophic trajectories is non-significant.

Air Flow	Surface	CN Tower
NE	0	1
SE	2	4
SW	13	23
NW	0	1
LAF	1	4

Table 1: Average number of exceedances of the O_3 AAQS (80 ppb) over the study period.

Geostrophic trajectories at the 1000 mb pressure level were therefore selected because of the routine availability of the 1000 mb pressure field and because of the simpler computations involved.

3. O_3 maxima and O_3night Distribution According Air Flows

The average O_3max and O_3night associated with each air flows are presented in Figure 3. It is seen that O_3 concentrations within the urban boundary layer of Toronto depend on air flow direction. The highest average O_3max was associated with SW air flows, 67 ppb at the surface and 84 ppb at the CN Tower. The second highest average O_3max was associated with light air flows, 57 ppb at the surface and 78 ppb at the CN Tower. SE air flows were associated with average O_3max of 48 ppb at the surface and 70 ppb at the CN Tower. The lower average O_3max were associated with NW and NE air flows, respectively 39 and 34 ppb at the surface and 52 and 48 ppb at the CN Tower.

A similar distribution was observed for average O_3night. At the surface, the highest average O_3night was associated with SW air flows, 22 ppb. At the CN Tower the highest average O_3night was associated with SW and light air flows, both 49 ppb. The second highest average O_3night was

Fig. 2.. The four sectors selected for the study and the 1985 emission estimates by Province and States of anthropogenic oxides of nitrogen and volatile organic compounds. Source: Ontario Ministry of Environment and Energy, Air Resources Branch, Air Quality and Meteorology Section.

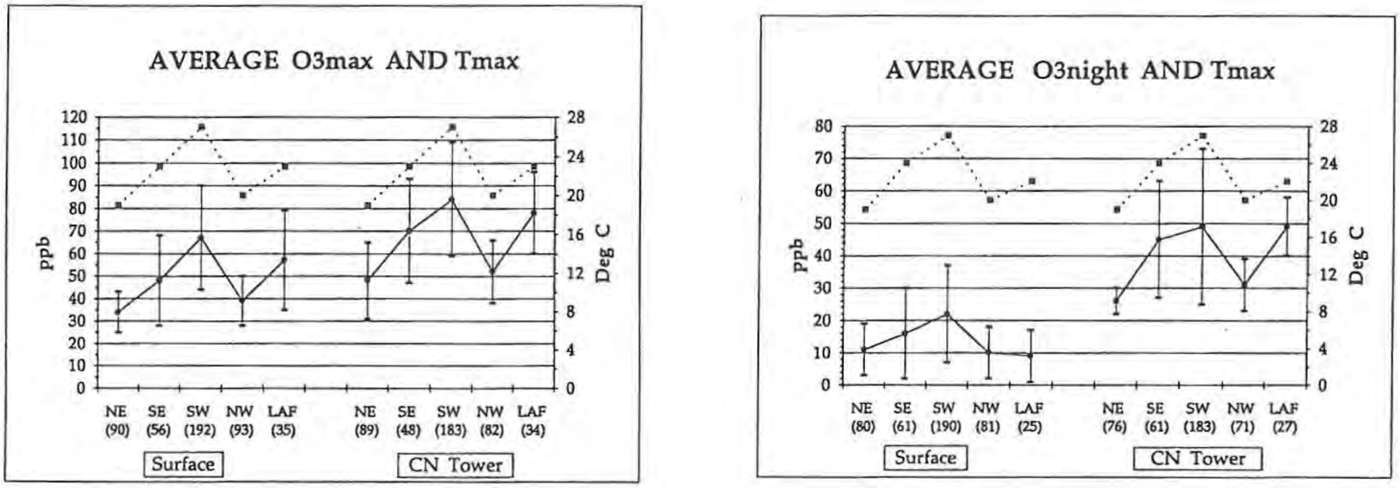

Fig. 3. Average (round marker) $O_{3\,max}$ (left) and $O_{3\,night}$ (right) from each air flow. The dashed line is average T_{max}. The vertical line through the average is the average +/- the standard deviation. In parenthesis is the number of back trajectories from each respective air flow during the study period.

associated with SE air flows, 16 ppb at the surface and 45 ppb at the CN Tower. The lower average O_3 night were associated with NE, NW and light air flows at the surface, 11, 10 and 9 ppb respectively; and with NW and NE air flows at the CN Tower, 32 and 26 ppb respectively.

It is well documented that tropospheric O_3 concentrations are positively correlated with air temperature and precursor emissions (Cardelino and Chameides, 1990; Stedman and Williams, 1990). Figure 3 indicates, in general, the expected positive correlation between average Tmax and O_3 concentrations. One reason why SW air flows are associated with the highest average O_3max and O_3 night may therefore be that SW air flows were associated with the highest average Tmax. Another reason, based on Figure 2, is that precursor emissions are the highest in the SW sector as well. Conversely, the lower average O_3max and O_3night are associated with NE and NW air flows and in these sectors average Tmax and precursor emissions are both lower.

The warm season was further divided in 4 sub-periods to verify the expected positive correlation between air temperature and O_3 concentrations within each of the four sectors. The sub-periods are: late spring (LSP), May 15-June 14; early summer (ES), June 15-July 14; mid-summer (MS), July 15-August 14; and late summer (LSU), August 15-September 14 (Figure 4). With the exception of O_3 concentrations associated with NW air flows, average O_3max and O_3night were, in general, higher in those sub-periods in which average Tmax was also relatively higher (ES and MS). With NW air flows, however, at both the surface and the CN Tower the highest average O_3night were associated with the lowest average Tmax and occurred in late spring. At the CN Tower, the highest average O_3max occurred in both late spring and mid-summer and again the late spring average O_3max was associated with the lowest average Tmax. Therefore, it would seem that O_3 concentrations associated

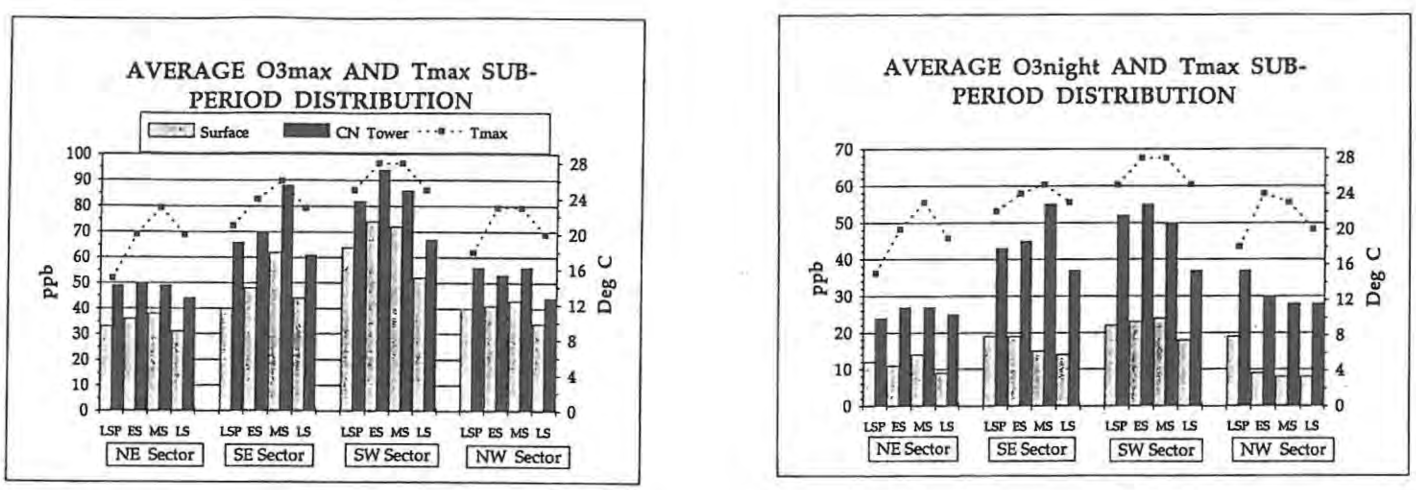

Fig. 4. Sub-period distribution of average O_{3max}, (left) O_{3night}, (right) and T_{max}.

CONDITIONS	AVERAGE O_3 max (ppb)
All	67
All Tmax, CC $\leq$ 0.4	77
All Tmax, CC $\leq$ 0.4, U_g < 25	81
All Tmax, CC $\leq$ 0.4, $U_g \geq$ 25	70
All U_g, CC $\leq$ 0.4, 24 $\leq$ Tmax $\leq$ 27	64
All U_g, CC $\leq$ 0.4, 28 $\leq$ Tmax $\leq$ 31	87
All U_g, CC $\leq$ 0.4, Tmax > 31	101

Table 2: *SW air flow average O_3max under different conditions at the surface.*

with NW air flows are not positively correlated with air temperature. A speculation as to the origin of this finding is discussed in Section 5.

3.1 Vertical O_3 Concentration Differences

The difference in average O_3max between the CN Tower and the surface as well as the difference between average O_3night are presented in Figure 5. Average O_3max and O_3night were both higher at the CN Tower than at the surface with differences in average O_3night being larger than differences in average O_3max. Nitric oxide (NO) is an effective scavenger of O_3. The average NO concentrations for the period 1987-1990 were 28 ppb at the surface and 2 ppb at the CN Tower. Therefore, one reason why average O_3 concentrations are lower at the surface than at the CN Tower may be more scavenging from NO at the surface as a result of higher NO concentrations. Another reason may be the fact that O_3 is subject to greater deposition at the surface.

One possible reason why differences in average O_3night are greater than differences in average O_3max may be related to differences in turbulence intensities between day and night. The greater daytime turbulence causes greater mixing within the boundary layer and therefore a more uniform vertical O_3 distribution, with resulting smaller O_3 concentration differences. Another reason may be the fact that O_3 is not produced during the night. During the day, the O_3 that is depleted at the surface is replenished from production and also from upper level O_3 that is mixed downward due to daytime turbulence. During the night, O_3 is no longer produced and replenishment from the upper level O_3 is inhibited due to weaker nighttime turbulence. As indicated in Figure 5, differences in average O_3night are largest with light air flows; a possible cause for this may be the generally weaker mechanical turbulence that is associated with light air flows. This weaker turbulence may enhance nighttime thermal stability, thereby further inhibiting vertical O_3 mixing.

3.2 Effect Air Flow on Toronto O_3 Amount

The above results indicate that each air flow will have a different impact on O_3 concentrations in Toronto. One measure of these impacts is indicated by the average number of exceedances of the Ontario 1-hour average ambient air quality standard (AAQS) for O_3 (80 ppb) over the study period (Table 1).

As is seen, most exceedances were associated with SW air flows, in accordance with the highest average O_3max being associated with SW air flows. A second measure is indicated by the air flow's contribution to the study period average O_3max; contributions are obtained from the percentage ratio of the sum of O_3max from all air flows to the sum of all O_3max from a given air flow. At the surface, the contributions from SW and SE air flows are 53.1 and 11.1% respectively; contributions from the NW, NE and light air flows are 15, 12.6 and 8.2% respectively. Again, SW air flows were associated with the greatest impact.

The above results would suggest that at locations where O_3 concentrations depend on air flow direction, the yearly frequency of occurrence of each air flow should also be considered when assessing yearly variations of the number of exceedances of applicable 1-hour average O_3 ambient air quality standards and yearly variations of the 1-year average O_3 concentration.

4. Effect of CC, Tmax and U_g on O_3max

The effect on O_3max of cloud cover (CC, tenths), air temperature (Tmax, Deg. C) and geostrophic speed (U_g, km/hr) prevailing along the back trajectories were qualitatively assessed at the surface for SW air flows. Table 2 shows the resulting average O_3max under different CC, U_g and Tmax conditions.

Generally sunny conditions (CC $\leq$ 0.4) thus result in higher average O_3max and it appears that O_3max is sensitive to speed of travel. These results are expected since less cloud cover corresponds to more sunlight reaching the boundary layer, thereby enhancing the required photochemical reactions and further increasing the surface air temperature, both of which can increase O_3 production (Cardelino and Chameides, 1990). A lower U_g allows greater precursors accumulation which may increase O_3 production (Stedman and Williams, 1990). The temperature effect is very evident.

This analysis indicates that even with air flows from the SW sector, O_3 concentrations that occur in Toronto may be relatively low if the meteorological conditions (especially Tmax) that prevail along the trajectory path are not favourable to O_3 production. The analyses also provided a basis for quantifying the "warm air temperatures" and "generally sunny" conditions required for exceedances of the ozone AAQS. For surface sites in Toronto it appears that exceedances of the O_3

AAQS are more likely to occur with Tmax $\geq$ 28 Deg C, CC $\leq$ 0.4 and $U_g \leq$ 25 km/hr.

5. Speculation of a Stratospheric O_3 Contribution

Following the finding that with NW air flows at both the surface and the CN Tower the highest average O_3night occurred in late spring in conjunction with the lowest Tmax (Section 3), a speculation, among many, was made regarding a possible cause for this. This speculation relies on the observation (i.e. weather system dynamics) that specific surface synoptic weather features and pressure patterns occur in conjunction with certain upper level synoptic features (Holton, 1979, pg. 136-143). Extending this observation further, it can be said that the upper level synoptic scale features that favour the transport of stratospheric O_3 down to the surface may correspond to specific surface synoptic scale feature, and therefore to specific synoptic scale surface air flows.

Intrusion events (i.e. mixing of stratospheric and tropospheric air) are likely to occur in the vicinity of wind speed maxima that are associated with upper levels low pressure troughs (Altshuller, 1987; Johnson and Viezee, 1981). At the synoptic scale, the air of stratospheric origin that has been mixed within the upper troposphere can be transported to the boundary layer by subsiding air motion that is associated with deep high pressure systems that extend from the surface to near the tropopause and that follow behind the passage of upper levels low pressure troughs (Johnson and Viezee, 1981; Danielsen, 1980; Wolf et al., 1979). Some authors have reported that stratospheric O_3 contributions near the surface should be most noticeable in spring because in this season stratospheric O_3 production and intensity of intrusion events both attain a maximum and the tropopause height is near its lowest yearly value (Johnson and Viezee, 1981; Singh et al., 1980). Other auctors have reported maximum 24-hour average O_3 concentrations and peak monthly averages in early to late spring: Meagher et al. (1987); Angle and Sandhu (1985); Mukammal (1985); and Danielsen and Mohnen (1977).

In southern Ontario upper levels low pressure troughs and wind speed maxima are usually associated at the surface with a cold front (baroclinic zone). As the front passes the prevailing air flow shifts to the NW and a high pressure system usually follows after the cold front. Therefore, it could be speculated that in southern Ontario an impact of O_3 of stratospheric origin should be most noticeable in spring with NW air flows. The finding that with NW air flows the highest average O_3night occurred in late spring in conjunction with the lowest Tmax, and that at the CN Tower the late spring average O_3max (also occurred with the lowest Tmax) was similar to the mid summer O_3max, appear to support the speculation. It is hoped that other investigator will conduct a study to verify if a stratospheric O_3 contribution does occur in spring and wether it is more noticeable with NW air flow or with all air flows.

6. Summary

It was found that within the boundary layer of Toronto, O_3 concentrations depend on air flow direction. This

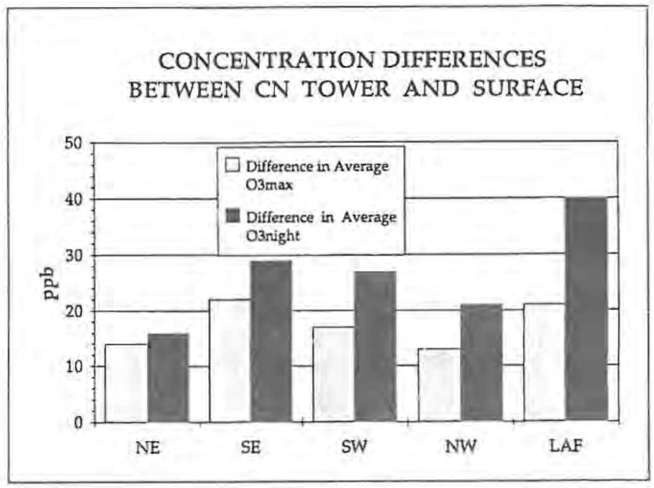

Fig. 5. Difference in concentrations between the CN Tower and the surface.

may be attributed to the non-homogenous spatial distribution of Tmax and precursor emissions. Average O_3max and O_3night were both higher at the CN Tower than at the surface with vertical gradients of O_3 concentrations being larger at night than during the day. It was also found that the meteorology that prevails along the trajectory path of air parcels affects the O_3max that occurs in Toronto. It is speculated that in southern Ontario a synoptic scale stratospheric O_3 contribution may be most noticeable in spring with NW air flows.

Acknowledgements

The authors are very grateful to Mr. Doug Vavasour for developing the back trajectory algorithm and to the staff of the Ontario Ministry of the Environment, Air Resources Branch, Air Quality and Meteorology Section, for providing comments on the paper.

References

Altshuller A.P. (1987) Estimation of the Natural Background of Ozone Present at Surface Rural Locations. *J. Air Poll. Control Ass.* 37, 1409-1417.

Angle R.P. and Sandhu H.S. (1985) Rural Ozone Concentrations in Alberta, Canada. *Atmospheric Environment* 20, 1221-1228.

Cardelino C.A. and Chameides W.L. (1990) Natural Hydrocarbons, Urbanization, and Urban Ozone. *J. Geoph. Res.* 95, 13971-13979.

Danielsen E.F. and Mohnen V.A. (1977) Project Dust Storm Report: Ozone Transport, in Situ Measurements and Meteorological Analyses of Tropopause Folding. *J. Geoph. Res.* 82, 5867-5877.

Danielsen E.F. (1980) Stratospheric Source for Unexpectedly Large Values of Ozone Measured over the Pacific Ocean During Gametag, August 1977. *J. Geoph. Res.* 85, 401-412.

Holton J.R. (1979) An Introduction to Dynamic Meteorology, 2nd edition. *Int. Geoph. Ser.*, 23.

Johnson W.B. and Viezee W. (1981) Stratospheric ozone in the lower troposphere: Presentation and interpretation of aircraft measurements. *Atmospheric Environment* 15, 1309-1323.

Meagher J.J., Lee N.T., Valente R.J. (1987) Rural Ozone in the southeastern United States. *Atmospheric Environment* 21, 605-615.

Mukammal E.I., Neumann H.H. and Nichols T.R. (1985) Some features of the ozone climatology of Ontario, Canada and possible contributions of stratospheric ozone to surface concentrations. *Arch. Met. Geoph. Biocl., Ser. A* 34, 179-211.

Peterson K. (1966) Estimating low-level Tetroon Trajectories. *J. App. Met.* 5, 533-564.

Singh H.B., Viezee W., Johnson W.B. and Ludwig F.L. (1980) The Impact of Stratospheric Ozone on Tropospheric Air Quality. *J. Air Pollut. Control Ass.* 30, 1009-1017.

Stedman J.R. and Williams M.L. (1990) A Trajectory Analysis of the Relationship Between Ozone in the United Kingdom and Precursors Emissions. Stevanage: Warren Spring Laboratory, LR 768 (AP).

Wolf G.T., Ferman M.A. and Monson P.R. (1979) The Distribution of Beryllium-7 within High Pressure Systems in the Eastern United States. *Geoph. Res. Lett.*, 6, 637-639.

Yap D., Ning T. and Dong W. (1988) An assessment of source contributions to the ozone concentrations in southern Ontario, 1979-1985. *Atmospheric Environment* 22, 1161-1168.

Towards a Canadian Meteorological Society

by
Morley Thomas

1. 1959-1966 The Expansion Years

The decade of the 1960s was a period of continued expansion in Canadian meteorology. Both research within, and the services provided by the Meteorological Branch increased markedly during this period. But, since many meteorologists left the discipline during these years to go to better paying positions elsewhere or to avoid shift work at the Forecast Offices it became necessary to hire three dozen or more new B.A. graduates each year.

The new recruits were trained at Toronto in the Meteorological Branch's intensive in-house training course. In addition, some honours graduates were hired each year and sent to one of the universities offering M.A. programs in meteorology -Toronto, McGill and Alberta. Also, some B.A. meteorologists with practical experience in the Meteorological Branch were supported each year in M.A. and Ph.D. programs at those universities. Technical training was improved immensely when the Department of Transport opened an Air Services Training School at Ottawa where introductory and advanced training courses were given to meteorological technicians.

Within the Meteorological Branch, much attention was given to the development of electronic gear which would lead to improved automatic reporting stations. To facilitate field meteorological research and instrument testing, a 100-acre farm was purchased north of Toronto. During these years a new three-level forecast system was being put in place at the Meteorological Branch's Central Analysis Office at Montreal, at several regional Weather Centres and at many Weather Offices throughout the country. The principal weather forecast products continued to be the public, aviation and marine forecasts and increasing assistance was given to those presenting television weather programs. The Branch became responsible for aerial ice reconnaissance and for an ice forecasting centre at Halifax.

Meteorological applications services were expanded into hydrometeorology, Arctic climatology and industrial meteorology. The secondment policy was continued with a dozen or so meteorologists working with other government departments in applying meteorology to agriculture, forestry, design and construction and other areas. Meteorological research was augmented within the Branch and, through subventions or grants, increasing support was provided for meteorological research at the universities. In-house, efforts in hail and precipitation physics research were expanded as the Meteorological Branch grew in size and more people with graduate degrees became available. Both government and university meteorologists participated in all operational and research aspects of the International Geophysical Year (1958-59) and in the early years of the International Hydrological Decade (1965-1974).

With such excellent federal government financial support for meteorological services and research it might be expected that the Canadian Branch of the Royal Meteorological Society would have grown faster than it did. In December, 1959, there were 334 members and, by the end of 1966, the membership had only increased to about 400. Many meteorologists continued to depart from the discipline and it was not until late in this period that concerted and effective efforts were made to recruit the new meteorologists. However, the Canadian Branch did begin a period of healthy activity growth. The concept of staging an annual congress in a university setting, often in conjunction with the annual meetings of Royal Society of Canada and other learned societies, was commenced with the 1960 Congress at Queen's University in Kingston. Another very positive note for the Canadian Branch was the publication of the first issue of Atmosphere in March 1963. Finally, during this period, planning was undertaken for the process of separating from the Royal Meteorological Society and forming an independent Canadian Meteorological Society. Then, having sparked the Society into much progress for five years, the Montreal meteorologists returned responsibility for the national Executive committee to Toronto members in 1964-65. The paragraphs that follow outline the Society activities over the period from 1959 until December 1966 when the Canadian Branch was formally dissolved.

2. Annual National Congresses

Although the first National Congress of the Canadian Branch of the Royal Meteorological Society was held at Queen's University in Kingston, Ontario during June 1960, there had already been five National Meetings of the Society in previous years. In the years immediately after World War II, the Meteorological Division held "refresher" courses for senior meteorologists from across the country, many of whom had been away from the class-room for a dozen or so years. These courses were then replaced by annual conferences to deal with policy and planning and other administrative matters of concern to the Regional meteorologists and the officers-in-charge of the principal Forecast Offices. As part of the conferences, two or three scientific sessions or discussions were held to help keep the senior meteorologists up to date in the science of meteorology.

In 1954, after the Central Analysis Office (now the Canadian Meteorological Centre) had moved to Montreal, it was decided to hold an OIC conference in that city to demonstrate the work of the office. By that year, scientists at McGill University were becoming active in meteorology and so the Montreal meteorologists, in collaboration with the RMS Canadian Branch, planned a Symposium on Meteorology with sessions at both the Central Analysis Office and McGill. The symposium, later considered to be the first National Meeting of the Canadian Branch, was a success and four more such National Meetings were held at Toronto during the 1956 to 1958 period.

At the second Meeting, in 1956, four papers were presented on different topics and these were published in the Canadian Branch Publications (CBP) series (vol. 7, no. 2). At the third National Meeting, held in October 1956, the subject was "Hydrology," a subject of increased interest after the floods in different parts of Canada - the Fraser River in British Columbia, the Red River in Manitoba and the Humber River and other streams in southern Ontario as a result of Hurricane Hazel. There were two papers and these were published as CBP vol. 8, no. 1. Later that year another Meeting was held and this time the subject was "Weather Analysis and Forecasting." There were seven speakers and the papers appeared in CBP vol. 8, no. 5. The fifth and last National Meeting of this series was held in November 1958. There were three papers but these were never published by the Canadian Branch.

With the move of the national Executive to Montreal in 1959 the Society became more academic or university oriented than it had been. Physicist-meteorologists on the new Executive committee were well aware that other scientific societies were holding their annual meetings at about the same time each spring at a particular university in conjunction with meetings of the Royal Society of Canada. This was becoming very popular with university members since it allowed them to attend the meetings of two or more societies with a week or so. The Learned Societies meetings were to be held at Queen's in 1960 so the Executive obtained permission for the Canadian Branch to participate. Consequently, members gathered at Kingston for the first National Congress on June 7-8, 1960 which included a joint session with the Royal Society of Canada. Members attending the Congress came away most enthused about the meetings and the facilities the university had made available. Accordingly, succeeding Executive committees have held each annual Congress at a university and, as often as possible, have used the same facilities as those used for meetings held by the other Learned Societies.

Over the next six years Congresses were held every spring, usually during the second week of June and usually in conjunction with the Royal Society and the other Learned Societies. The 1961 Congress was hosted by the University of Montreal where a dozen papers were presented at two sessions on a) ozone and the stratosphere and b) dynamic and synoptic meteorology. Also, there was a joint session with the Royal Society held at McGill University where another dozen papers were given on a) precipitation physics and b) the troposphere. It is interesting to note that a special public session was presented that year on a new subject "Observations by Satellite" and that the Congress registration fee was $1.00.

The next year, 1962, the Congress was held at McMaster University in Hamilton, Ontario. Arrangements were made with the Controller of the Meteorological Branch, J.H.R. Noble, to present the Patterson Medal to the 1961 winners, along with the Royal Meteorological Society awards, at a Congress luncheon and this practice was continued for many years. Again, a joint session was held with the Royal Society at which papers were given on the linkages between successive atmospheric layers. Other Congress sessions dealt with dynamic, synoptic and physical meteorology, upper atmospheric physics and hydrometeorology. In 1963, the Congress was held at Laval University in Quebec City at about the same time as meetings of the Royal Society and the Canadian Association of Physics. Here, for the first time, the Annual Meeting of the Canadian Branch, previously held in January each year, was held at Congress. More than 100 registered for the Congress at which four sessions were held and 23 papers presented. Another important event at the Congress was an evening Symposium on Space Physics, a subject in which many attending meteorologists were keenly interested.

The fifth National Congress was held at Dalhousie University in Halifax where an opening joint session was held with the Canadian Association of Physicists on the general circulation and ozone. Also, there were 19 papers given at sessions dealing with a) physical and dynamic meteorology b) analysis and prediction and c) the troposphere. A feature of the annual meeting was a discussion on the possibility of forming an independent Canadian Meteorological Society. Members had been polled by mail on the subject and it was reported that 85% of the members responding, half the membership, were in favour of developing plans to break away from the Royal Meteorological Society. An ad hoc committee was established to develop a provisional constitution by the end of 1964.

In 1965, Congress moved to western Canada for the first time when the meetings were held at the University of British Columbia in Vancouver. More than 60 members and guest attended the sessions which were held on weather forecasting, cloud and precipitation physics, atmospheric dynamics and, for the first time, there was a session on dynamic meteorology and numerical weather prediction. At the Annual Meeting a draft constitution and new proposed by-laws were presented to the members but there was too little time available for proper discussion and so comments were later solicited by mail from all members across the country.

The seventh and last Congress of the Canadian Branch was held at the University of Sherbrooke in June 1966. The scientific sessions, six in all, were held in conjunction with the other Learned Societies although there were no joint sessions. It was a healthy scientific program with 28 papers presented at sessions dealing with mesometeorology, dynamic meteorology and numerical prediction, atmospheric diffusion and physical meteorology. By the time of the meetings, the members had already voted by mail in favour, with a vast majority, of an independent Canadian society and had accepted a plan of organization. Accordingly, the only task remaining at the Annual Meeting was to make the decision official and to name an effective date of January 1, 1967. This was done in the presence of, and with the full concurrence of, the president of the Royal Meteorological Society, Dr. G.D. Robinson, who the Canadian members had invited to participate in this historic meeting.

(To be continued in the next issue)

1995 CMOS PRIZES AND AWARDS: REMINDER

The Canadian Meteorological and Oceanographic Society's annual call for nominations for its Prizes and Awards Program is now underway.

All members are encouraged to consider nominating individuals of the meteorological or oceanographic community who have made significant contributions to one or both of these fields. The award categories are:

- *President's Prize*
- *Tully Medal in Oceanography*
- *Applied Meteorology*
- *Applied Oceanography*
- *Operational Meteorology*
- *Graduate Student*
- *Environmental Citation*
- *Media Weather Presentation.*

Each category has different and specific nomination criteria which must be met before any nomination can be considered. For details, pleasations to be received by the Secretary of the Prizes and Awards Committee. Nominations should be made to:

Mr. David Phillips, Secretary
CMOS Prizes and Awards Committee
Atmospheric Environment Service
700 - 1200 West 73rd Avenue
Vancouver, B.C. V6P 6H9

Telephone (604) 664-9050
Fax (604) 664-9195

The Ocean Circulation Mailing List

CNC-WOCE has set up an electronic forum for informal discussions about any and all aspects of ocean circulation. Hopefully this forum will help us overcome the geographic and institutional gaps that separate the ocean circulation community, by fostering rapid exchange of ideas, viewpoints, and information.

In the first half of 1995, CNC-WOCE intends to sponsor a workshop on ocean circulation, at which modellers, analysts, and observationalists will get together to:

1. Review and summarise the progress of current Canadian WOCE projects (who is doing what?)

2. Outline the extent and availability of global WOCE data sets. (What data are there? Can I use them? How can I get them?)

3. Outline the plans by international WOCE for analysis, synthesis and modelling.

4. Begin planning of Canadian WOCE projects for the 1996-1999 triennium.

This workshop will be open to all interested parties, and CNC-WOCE hopes to partially fund the attendance of participants. The agenda and timing are not finalised; a consensus should emerge from discussions on the ocean circulation electronic forum.

To Participate:

Send an e-mail message to
majordomo@Phys.Ocean.Dal.Ca with the message:

subscribe oceancirc
end

It is also requested that new subscribers send the following information to WOCE@Dal.Ca:

1. Full Name
2. Affiliation
3. Phone & FAX number
4. E-mail address
5. A brief (1-5 sentences) paragraph outlining your interests in WOCE and/or ocean circulation
6. A brief paragraph outlining the sort of WOCE project that you might be interested in participating in from 1996.

To Send Messages to All Participants:

Send an e-mail message to
oceancirc@Phys.Ocean.Dal.Ca,
copies will then be made and distributed automatically.

To Suspend Participation:

Send an e-mail message to
majordomo@Phys.Ocean.Dal.Ca with
the message:
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Barry Ruddick
CNC-WOCE

Fifth AES / CMOS Workshop on Operational Meteorology

The Coast Terrace Inn,
February 28 to March 3, 1995,
Edmonton, Alberta, Canada

Theme

Operational Meteorology in a Multi-disciplinary Environment

Program Committee

Glenn Vickers, Co-chair
Carl McLeod, Co-chair
Gary Burke
Neil Parker
Neil McLennen
Gary Hufford
Ken Mielke
Gerhard Reuter

Local Arrangements Committee

Brian Paruk (403-951-8604)

Synopsis of Sessions

Tues.	*AM:*	Numerical Weather Prediction
Tues.	*PM:*	Technology Developers' Forum
Wed.	*AM:*	Observation Systems and Remote Sensing
Wed.	*PM:*	Observation Systems and Remote Sensing II
Thurs.	*AM:*	Applied Meteorology
Thurs.	*PM:*	Commercialisation
Fri.	*AM:*	Mesoscale systems and Forecasting

General Information

The Fifth AES / CMOS Workshop on Operational Meteorology will be held February 28 to March 3, 1995 at the Coast Terrace Inn, Edmonton, Alberta, Canada.

Accommodations

All sessions will take place at the Coast Terrace Inn, Edmonton, Alberta, Canada. A block of rooms has been reserved for meeting attendees at the special price of **$69/night** plus tax. **Note that this is below the regular government rate but you must indicate that you are attending the Workshop when you are registering.** Registrations must be made prior to February 5, 1995. Reservations made after that date will be on a space available basis. We urge you to register early.

For reservations, please write or call the *Coast Terrace Inn, 4440 Calgary Trail North, Edmonton, Alberta T6H 5C2 (403-437-6010, Fax: 403-437-0153*; Toll free in Canada and the US: 1-800-426-0670.)

Registration

Preregistraton fees are $25 for Environment Canada employees working in the Atmospheric Environment Program, $110 for CMOS members, $50 for students, and $150 for others. After January 31, 1995, a late fee of $25 will be applied. The registration fee includes admission to meetings and one dinner ticket.

Preregistration fees are valid only if payment is received by January 31, 1995. Registration payment may be made with cash, personal/business/traveller's cheque, or money order. We urge you to preregister by sending the appropriate remittance together with your name, affiliation, and complete mailing address to:

AES/CMOS Workshop Registration
c/o Brian Paruk
Environment Canada
Monitoring and Systems Branch
Twin Atria Building, Room 200
4999 - 98 Avenue
Edmonton, Alberta T6B 2X3
Canada

Refunds will be granted only for cancellations received before February 15, 1995. The registration desk at the Coast Terrace Inn will be open for Workshop registration on Monday, February 27 at 7:00 p.m. and Tuesday through Thursday at 7:30 a.m.

Travel Information

Canadian Airlines International has been designated the official air carrier for the workshop. ***Please quote registration number 5999 when booking.*** Canadian has offered our travelling delegates the following discounts:

- Guaranteed savings of 15% on full Business and Economy fares within Canada.
- Savings of 35% off the full economy fares within Canada with 2 nights minimum stay and 7 days advance purchase (change and cancellation penalties apply).
- Advance purchase fares often offer even greater savings and if you qualify, you will be offered the lowest available fare at time of reservation (of course, all the usual restrictions regarding change and cancellation will apply depending on fare level).
- American delegates will be guaranteed up to 30% off the regular economy fares. (Discount only applicable on Canadian Airlines scheduled flights.)
- Travellers will be offered a bonus of 1000 Canadian Plus points in addition to the regular Canadian Plus miles earned.
- For those with significant cargo, Canadian has offered 25% off regular tariffs within Canada (quote the registration number at local Canadian Air Cargo offices).

If you are making reservations through you local travel agency, please have them ensure that their agent registers your booking, regardless of the fare, with ***Canadian Airlines' Conventionair Reservation Office*** (1-800-665-5554; in Toronto 416-798-2288; in Montreal 514-847-0611; or Fax 514-847-2055).

The Coast Terrace Inn is a 20 minute ride north of the Edmonton International Airport along Highway 2 (major north-south route). Taxi fares are typically just under $30. If you are driving, the hotel is along Calgary Trail North (Highway 2 magically turns into the "Calgary Trail") just a short distance north of Whitemud Drive. Complimentary heated underground parking is available at the hotel.

Workshop Banquet

A Workshop banquet will be held on Thursday, March 2 at 6:30 p.m. One banquet ticket is included with registration. Extra banquet tickets are available at $25 each. A reception/cash bar will be held at 6:00 p.m. An Icebreaker (cash bar) will be held on Monday, February 27 at 7:00 p.m. Breaks will be held during the morning and afternoon sessions.

It is our sincere desire to make the Workshop productive for all attendees. Those that are disadvantaged or that have special needs should call the Local Arrangements Chairman at 403-951-8604 four to six weeks prior to the Workshop to request special arrangements. We do want to ensure that your stay in Edmonton is pleasant.

Long-range Weather and Crop Forecasting Working Group Meeting Announcement

The long-range weather and crop forecasting group (recently formed in Canada) held its first meeting in April 1993 at the National Hydrology Research Centre, in Saskatoon. About forty participants attended the meeting and a report (proceedings) containing extended abstracts of the presentation made at the meeting, was prepared and distributed to all participants by August, 1993.

A second meeting of the working group is planned for third or fourth week of March 1995. The venue of the second meeting will be the headquarters of the Canadian Wheat Board in Winnipeg and the theme of the meeting will be "La Niña and its implication for North American climate and agriculture." It is hoped that the theme may help spark discussion on detecting and monitoring La Niña signal through analysis of North American data on climate, agriculture and other related parameters. It is expected that the format of the meeting will be similar to that of the first meeting with a number of short presentations, followed by informal discussions by various working groups.

For more information on the second meeting of the *Long-range Weather and Crop Forecasting Working Group*, please contact Ray Garnett (Canadian Wheat Board, Winnipeg, phone: (204) 983-3563) or Madhav Khandekar (Atmospheric Environment Service, Downsview, Ontario, phone: (416) 739-4913).

COMMENTS / COMMENTAIRES

The article by Ambury Stuart entitled **CMOS AND THE NEW PROPOSED DEFINITION OF ENGINEERING**[1] was informative and disturbing.

It appears that a "cold war" began in Ontario around 1984 between professional engineers and natural scientists. Hats off to the Canadian Association of Physicists for their intervention! This "war" has spread to the Yukon, B.C., Alberta, Saskatchewan, and Manitoba, and has "flared up" recently in Nova Scotia. CCPE mounted a "new campaign" in 1990; NSSC "counter-attacked" in October 1993. the "war" appears endless.

Ambury, what has the NSSC accomplished in 10 meetings and in two joint meetings with representatives of CCPE? Are the NSSC and CCPE jointly trying to produce an acceptable definition for the "practice of professional engineering?" What is the situation in the N.W.T., Québec, New Brunswick and Newfoundland?

Until CMOS members are apprised of the: 1) objectives, 2) progress to date on resolving the issues, and 3) outstanding issues the NSSC has been unable to resolve with the CCPE, CMOS members are ill equipped to make their views known to the appropriate authorities in the province or territory where they practice meteorology or oceanography. Please provide CMOS members with "detailed battles orders" in the CMOS BULLETIN soon.

John H. McBride
Meteorologist Emeritus

CMOS NEW MEMBERS
NOUVEAUX MEMBRES DE LA SCMO

Mrs. Julie Driver	University of Regina (SK),	Student
Mr. Russel Sampson	University of Alberta (AL)	Student
Mr. David Beerman	Royal Roads (BC)	Student
Mr. Fraser Davidson	Memorial University (NF)	Studient
M. André April	University Laval (QC)	Étudiant
Mr. Jimmie Smith	Bedford (NH,USA)	Regular
M. Bruno Tremblay	MGill University (QC)	Student
Mr. Howard R. Edel	Ottawa (ON)	Regular
M. Michel Dorais	UQAM (QC)	Étudiant
Mr. Divid M.L. Sills	York University (ON)	Student

[1] CMOS BULLETIN Vol. 22, No. 4 August 1994, p. 23-24

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Pour dossiers seulement: l'étudiant(e) doit inscrire le nom de son institution et l'année où il (elle) finira ses études.

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Please enroll me as a member of the Society. I attach a cheque to the amount of $__________ payable to the Canadian Meteorological and Oceanographic Society for membership fee and/or publication subscriptions. I also include a tax-deductible donation of $_______ for (indicate):

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If applying for student membership, please obtain signature of one of your professors.

______________________________ (Signature) ______________ (Date)

Mail completed form to CMOS at the address above.

Je désire devenir membre de la Société. J'inclus un chèque au montant de $ _________ payable à la Société canadienne de météorologie et d'océanographie pour la cotisation de membre et/ou les frais d'abonnement aux périodiques. J'inclus aussi un don déductible d'impôts de $ _________ pour (indiquez):

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Faire parvenir la demande d'adhésion complétée à la SCMO à l'addresse ci-dessus.