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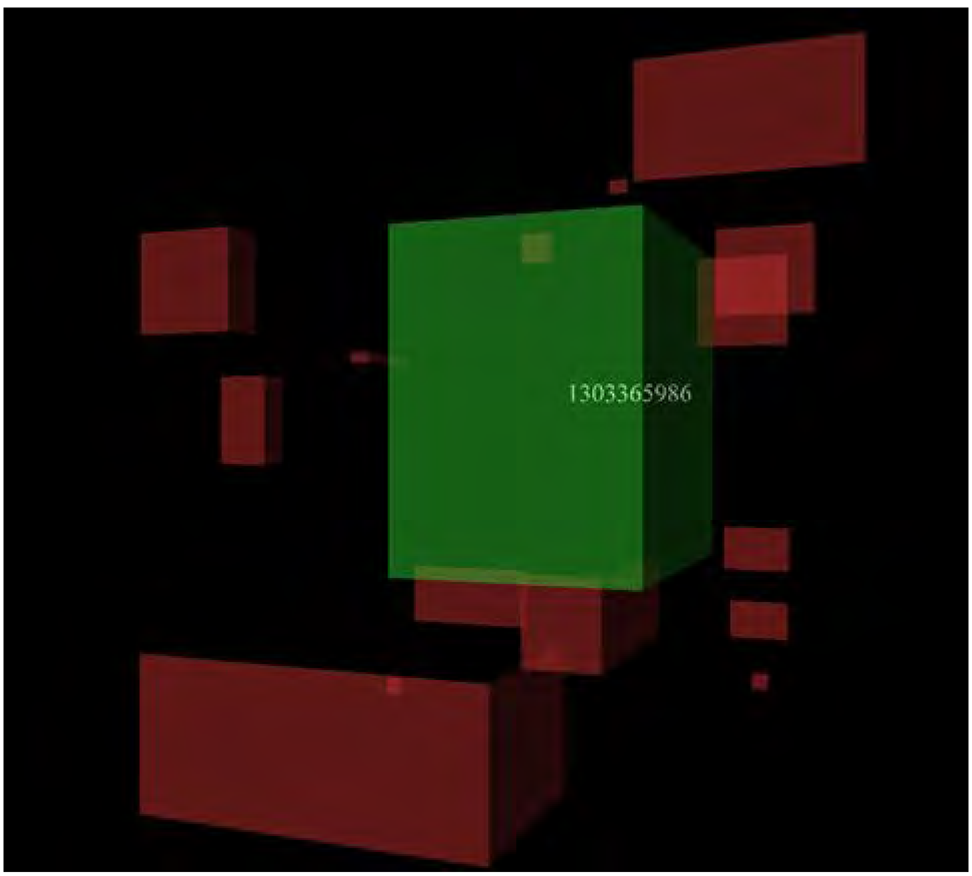
Canadian Meteorological and Oceanographic Society

La Société canadienne de météorologie et d'océanographie

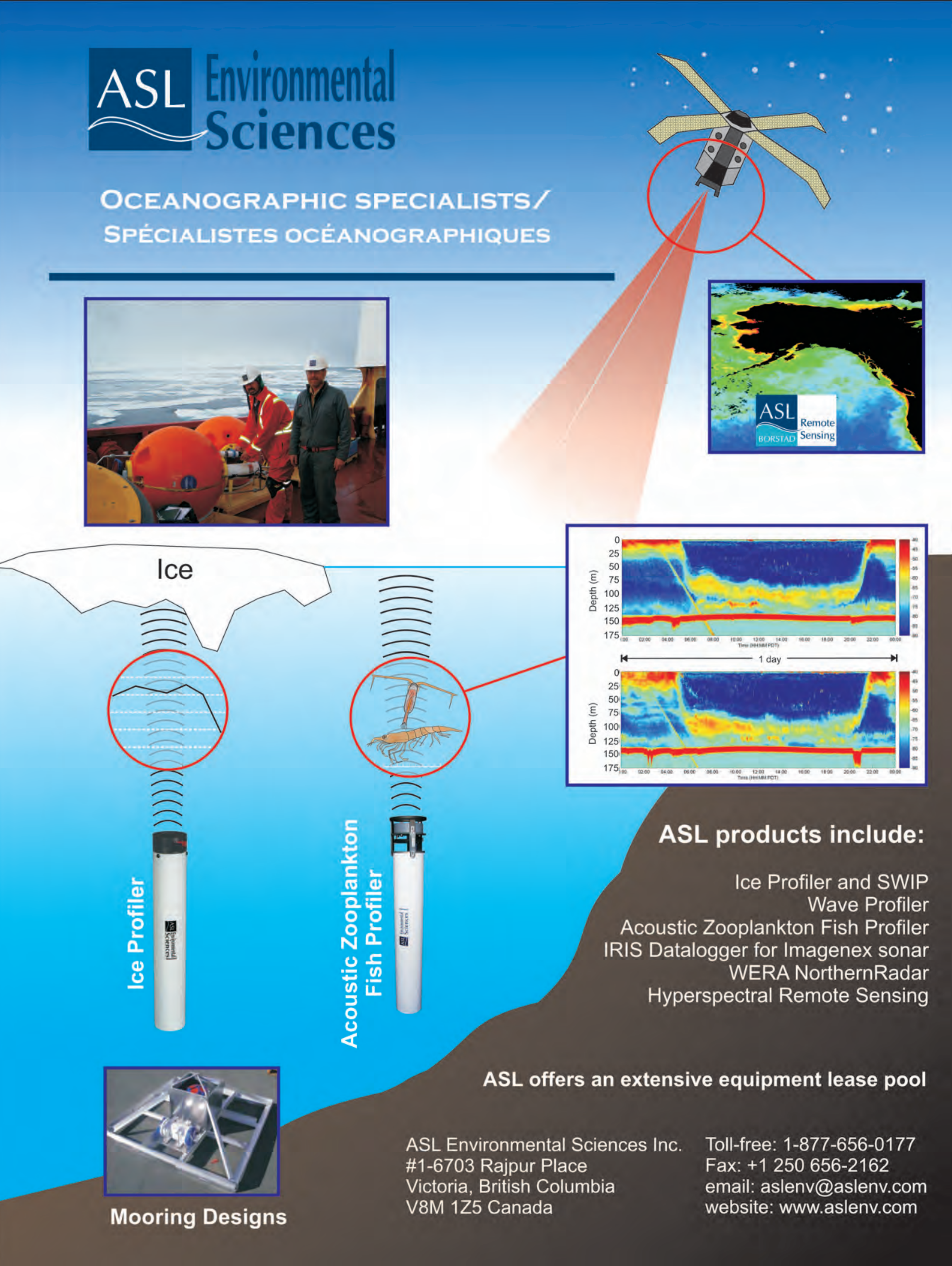
CMOS BULLETIN SCMO

April / avril 2013 Vol.41 No.2

Creation of a Large Rainfall Storm Database



Création d'une grande base de données d'averses de pluie



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....from the President's Desk / Allocution du président

Friends and colleagues:

Peter Bartello
CMOS President
Président de la SCMO

As I write this column my email is humming with messages about the final arrangements for our upcoming joint congress in Saskatoon with the CWRA and the CGU. It is already clear to me that it will be a large and very successful event, with all the usual ingredients of our congress plus the added stimulus from the other two geophysical societies. Many thanks to organisers Craig Smith, Geoff Strong, Virginia Wittrock and their teams. It is only appropriate that the Saskatoon meeting will also be the venue for the first real face-to-face meeting of the newly formed Canadian Societies for the Geophysical Sciences, a loose affiliation of groups like CMOS able to speak with one voice on matters of concern to geophysical scientists. With the promise of exciting and important new research results, many exhibitor booths informing of new developments and services related to meteorology and oceanography, plenary and public lectures by leading researchers, special side events such as the Teachers' Day that promote educational activities, and the social events that celebrate and reward achievement and bring our community together, I look forward to meeting with as many CMOS members as I possibly can. Please make your arrangements as soon as possible.

I am particularly looking forward to our Annual General Meeting, where we are hoping for some feedback on upcoming changes to CMOS governance from as broad a slice of the membership as possible. This was discussed in this column in the last issue of the *CMOS Bulletin SCMO*.

In other news CMOS has recently written a letter to the international body that assigns internet addresses (the Internet Corporation for Assigned Names and Numbers (ICANN)) opposing the application of the US cable weather channel to reserve internet addresses ending with ".weather". [See copy of the letter sent to ICANN on page 44. It was later sent to The Honourable Christian Paradis, Minister of Industry and Minister of State (Agriculture)].

(Continued on page 43 / Suite à la page 43)

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Inside / En Bref

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CMOS exists for the advancement of meteorology and oceanography in Canada.

Le but de la SCMO est de stimuler l'intérêt pour la météorologie et l'océanographie au Canada.

CMOS Bulletin SCMO
"at the service of its members / au service de ses membres"

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Cover Page: The creation or a large database that contains over 25,000 rainfall storm cells required specialized processing software since the underlying weather radar data spans 10 years of data at a 5-minute interval with a 1 km^2 grid size resolution. The cover image shows one of the system displays that depicts the space-time extents of a series rainfall storm cells. Looking at the image, the foreground boundaries of each rectangle represents the maximum geographical extent of each storm cell in a UTM coordinate space while the depth of each box is the given storm's cell total duration. The front surface of each box is located at the very beginning of rainfall while the back surface is situated at the very end of the storm. The position and size of each box represents the spatio-temporal extents of several storm cells that have different start/end times and variable non-overlapping space. The green box has a numeric identifier that indicates a storm cell where all attributes satisfy the selection criteria; hence, was added to the rainfall storm database. To learn more, please read Jobin's *et al* first article out of four on **page 45**.

Page couverture: La confection d'outils informatiques spécialisés a été nécessaire lors de la création d'une banque de données contenant au-delà 25,000 cellules orageuses, calculées à partir de 10 ans de données radar d'un intervalle de 5 minutes et d'une résolution de 1 km^2. L'image de la page couverture affiche une portion de calcul ou les côtés des boîtes représentent les limites spatio-temporelles d'une série d'averses. La surface frontale des boîtes décrit l'étendue géographique d'analyse en projection cartographique TMU, tandis que la profondeur représente le temps. La surface avant de chaque boîte est positionnée au tout début de l'averse tandis que la surface arrière est à la fin de l'averse. La boîte verte et étiquetée, signifie que tous les attributs de cette cellule orageuse rencontrent les critères de sélection et conséquemment, sera rajouté à la base de données. Pour plus d'information sur le projet veuillez lire le premier article de quatre de Jobin *et al* en **page 45**.

....from the President's Desk / Allocution du président
(Continued / Suite)

The basis for our objection was two-fold: first, there are more private companies than this one providing weather information around the globe and this would seem to give them an unfair advantage (an objection also registered by the government of Australia); second, these very simple and intuitive web addresses would be amongst the first people unfamiliar with our science might type. Our fear was that this would interfere with the authority of national weather services as the only legal source of weather warnings and public safety information. ICANN's Governmental Advisory Committee will decide whether or not to make a formal complaint about this application in April. ICANN will then make the final decision. ICANN does not have to comply with the governments' wishes, but must provide "*well-reasoned arguments"* if it decides to deny any rejection request. It is the hope of CMOS that there will be many objections such as ours.

Finally, as I enter the home stretch of my year as President of CMOS, I am very happy to have advanced some of the files left to me by my predecessors and to have started a few others of my own. In thinking of the future I suppose one of my greatest concerns must be the funding situation for our science. The current government appears not to be willing, or in a position to expand government's contribution. Via NSERC they have recently funded university researchers within the Climate Change and Atmospheric Research programme, although they were careful to point out that this would only involve a single call for proposals. Successful applications are now beginning a five-year period of at least some stability, but we have no news of future research funding for our science beyond the usual NSERC programmes available to all of the natural sciences and engineering. An important future priority of CMOS and perhaps the entire geosciences community should be to try to convince all levels of government and Canadians in general of the need for this.

Peter Bartello
CMOS President / Président de la SCMO

Moving Again?!?!

Yes, as of April 1, CMOS Offices will be located in 200 Kent Street, on the 4th floor. There will be no changes for the fax and telephone numbers.

On déménage!?!?

Oui, à partir du 1er avril, les bureaux de la SCMO seront situés au 200, rue Kent, au quatrième étage. Il n'y a aucun changement pour les numéros de téléphone ou de facsimilé.

Next Issue *CMOS Bulletin SCMO*

Next issue of the *CMOS Bulletin SCMO* will be published in **June 2013.** Please send your articles, notes, workshop reports or news items before **May 3, 2013** to the address given at the top of page 2. We have an URGENT need for your written contributions.

Prochain numéro du *CMOS Bulletin SCMO*

Le prochain numéro du *CMOS Bulletin SCMO* paraîtra en **juin 2013.** Prière de nous faire parvenir avant le **3 mai 2013** vos articles, notes, rapports d'atelier ou nouvelles à l'adresse indiquée au haut de la page 2. Nous avons un besoin URGENT de vos contributions écrites.

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March 12, 2013

To whom it may concern,

I am the President of the Canadian Meteorological and Oceanographic Society (CMOS) which is the national association of over 800 meteorologists, oceanographers, climatologists and allied professionals whose goal is the advancement of these sciences and services based upon them. CMOS represents all three of the public, private and academic sectors, all of which are involved in the provision of weather services. We advocate a free and open market for the provision of private and specialised weather services and a single authoritative government source for public weather warnings. In existence in one form or another since 1939, CMOS has deep connections with other national meteorological organisations and international bodies such as the World Meteorological Organisation (WMO), the International Council of Scientific Unions (ICSU) and the International Association for Meteorology and Atmospheric Sciences (IAMAS).

As a key part of the Global Weather Enterprise, CMOS wishes to object to the proposal to ICANN of The Weather Channel (TWC) of the USA to reserve the domain .weather for their exclusive global use. In particular, we support the objection of Accuweather to the TWC application.

We believe that the application by TWC is completely inappropriate for the following very important public policy reasons:

1. TWC is just one of many sources, both public and private, of weather information. Exclusive use of the .weather domain name would provide TWC with an anti-competitive privileged position in Canada and world-wide for the provision of weather information;

2. Granting this application would undermine the authority of national weather services, such as the Meteorological Service of Canada, as the only legal source of weather warnings in their respective countries;

3. Positioning TWC, a commercial weather service provider, as the safety and preparedness expert for weather driven emergencies through its control of the .weather domain, would undermine the authority of other public safety agencies.

CMOS opposes the application of TWC in the strongest possible terms; no single private weather enterprise such as TWC should have exclusive use of and control over the .weather domain.

Yours respectfully,

Peter Bartello
CMOS President

Spatial-Temporal Rainfall Storm Characteristics

Part I: Building a Rainfall Storm Database

by Daniel Jobin[1], Peter Jolly[1] and Steven Chan[2]

Abstract: A series of four papers summarize the key findings of over ten years of research in hydrometeorology using weather radar-derived rainfall data near the City of Edmonton, Canada. Although the initial study objective was to determine spatial characteristics of rainfall storms, subsequent analyses yielded more complex storm attributes such as “Areal Reduction Factors”, “Spatial Design Storms”, storm-cell spacing statistics and, “Depth-Duration-Area-Frequency” curves. These advanced spatial characteristics are of great interest to water resources professionals that are tasked with designing drainage infrastructure and currently use overly simplistic approaches in estimating rainfall input. The breath of the research eventually enabled the development of promising alternative methodologies for creating spatiotemporal “Design Storms”; results that could significantly impact how costly drainage structures are designed.

Résumé: Une série de quatre articles présente une synthèse des dix ans et plus de recherche en hydrométéorologie utilisant des données de précipitation radar aux alentours de la ville d’Edmonton, Canada. Bien que le but initial du projet de recherche était de seulement calculer des caractéristiques spatiales des événements pluvieux, les analyses ultérieures éventuellement abordèrent des attributs complexes notamment; des ‘Facteurs de Décroissance Spatiale’, des ‘Averses de projets’, des statistiques de distances intercellulaires d’orage et, des fonctions ‘Profondeur-Durée-Surface-Fréquence. Ces dernières caractéristiques d’averses sont particulièrement importantes en génie de ressources hydriques ou les professionnels utilisent maintenant que des méthodes simplistes pour évaluer l’apport pluvieux dans leurs calculs de dimensionnement d’ouvrage de drainage. L’envergure des travaux de recherche a permis éventuellement d’élaborer des méthodologies spatio-temporelles innovatrices de calculer les ’Averses de projet - des résultats qui pourraient changer de façon importante l’approche courante de concevoir l’infrastructure de drainage.

Preamble

This article is the result of over ten years of applied research and development in hydrometeorology; specifically, spatiotemporal characteristics of rainfall storms near the City of Edmonton, Canada. Although the initial project’s objective was to generally focus on the development of spatial characteristics for rainfall storms based on using weather radar data, the second follow-up study pushed the endeavors well beyond their intended purposes and resulted in seminal work for water resources applications.

The large amount of research findings was organized into a series of four technical papers that progressively guide the reader toward more complex findings and ultimately, proposed alternatives to the current simplistic “Design Storm” methodology.

The topics of the four papers are:

1. Building a Storm Database
2. General Storm Characteristics
3. Arial Reduction Factors
4. Alternative Design Storm Method

Introduction

Millions of dollars are spent annually in constructing drainage-related structures that are still designed today using simplistic techniques in determining the most significant input to designs: **precipitation**. Historical precipitation data is often used in designing water resources infrastructures such as dams, reservoirs, spillways, irrigation and diversion channels as well as culverts and storm sewers. The dimensioning of these structures is often dictated by precipitation statistics and rain gauge data has practically always been the only source of precipitation information. Also, the Intensity-Duration-Frequency (IDF) precipitation data product, generated from single site (point source) is practically the only tool used by water resources professionals in determining design rainfall inputs for computing design flow rates or runoff volumes. Figure 1 presents a typical IDF data graph produced by Environment Canada. This example uses rain gauge data observed at the Edmonton City Centre Airport.

IDF data has been available for many years and are periodically updated as the periods of record increase with time. In 1990, IDF curves for over 550 stations were available from Environment Canada. Although more recent graphs are available for many stations, the ongoing reduction of the total number of active weather stations in Canada has resulted in a substantial reduction in “to-date” IDF data.

[1] Kije Sipi Ltd - RadHyPS Inc

[2] City of Edmonton

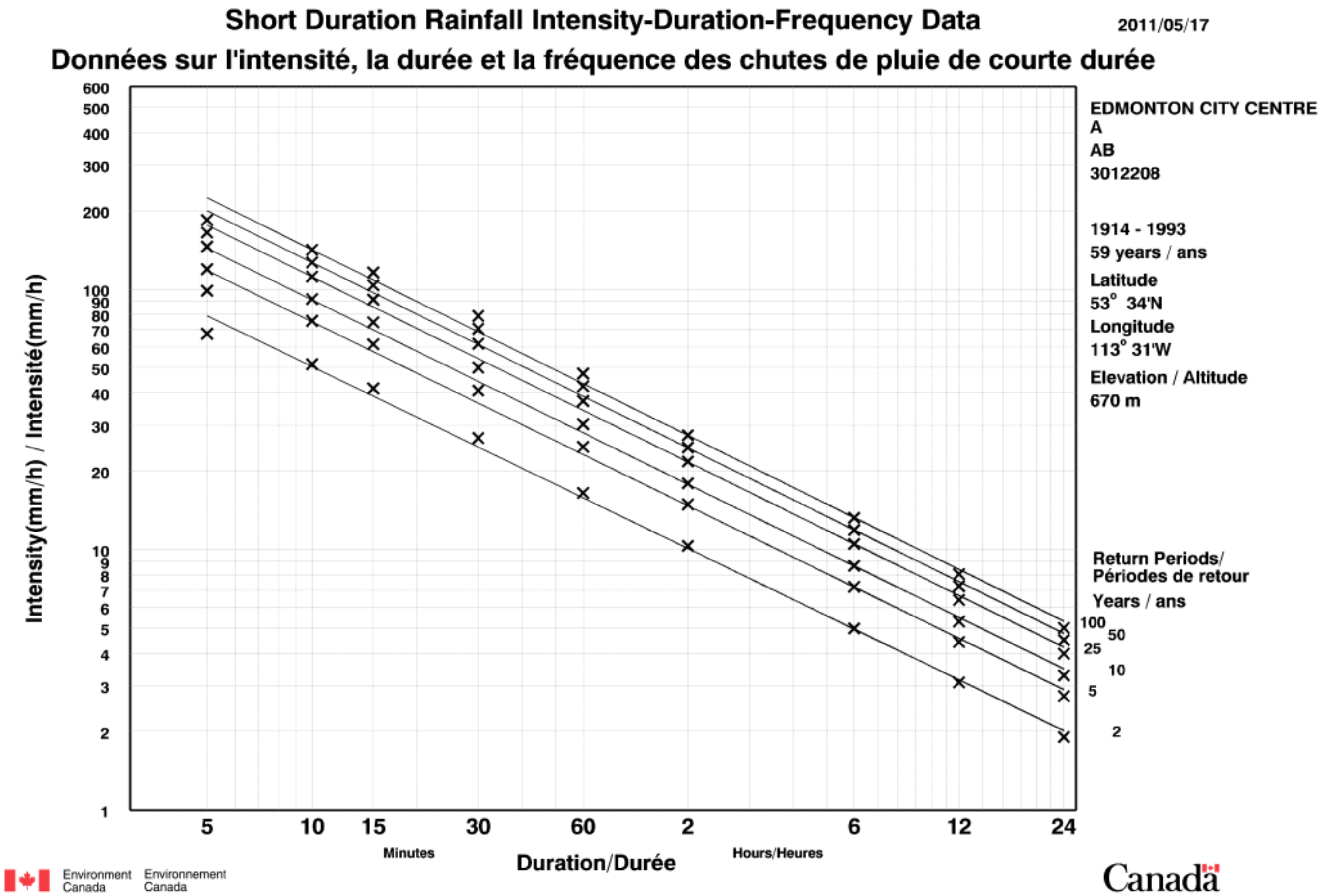

Figure 1: Intensity - Duration – Frequency Data (Edmonton)

However, the updating and even future usage of these statistical functions is now being questioned by Canadian hydrologists, especially data collected within the last 30 years. There is an increased uneasiness in mixing old precipitation data with recent data, the stationary criterion no longer being satisfied due to climate and land use change impacts. Furthermore, considering that many water resources applications need to typically extrapolate the datasets well beyond the actual period of record in order to obtain, for example, a design 1:100 year rainfall amount, potential errors in estimates could be further magnified.

The increased number of major flooding events and litigation cases in Canada over the last 20 years has brought forward the IDF issue as well as a broader assessment into water resources input rainfall design methodologies.

Hydrologists and water resources engineers have always known there were limitations in using point source rainfall data such as rain gauge IDF curves for watersheds and sewersheds; however, there are no available alternatives. Furthermore, the extent of the limitations is not fully appreciated and, in fact, is continually ignored by practitioners by their assumption that rain gauge data statistics can be conservatively applied uniformly throughout the entire watershed surface. This assumption fails to recognize issues associated with the huge difference between the design catchment area (i.e. watershed) and the data collection area (opening) of a rain gauge. The limitations are best presented using a typical water resources design scenario such as culvert sizing project.

Figure 2 shows a generalized map of the Whitemud Creek watershed (large grey polygon) within the City of Edmonton and is approximately 50 km^2 in area and has a maximum length/width of ~12/~8 km.

The star shows the future location of a new culvert while the triangles are rain gauge stations, of which only one is located within the watershed. Two hypothetical convective storm cells are also shown as colour-coded rainfall accumulations. Each discrete storm cell contributes to the combined flood flow observed at the culvert location - an important hydrologic distinction.

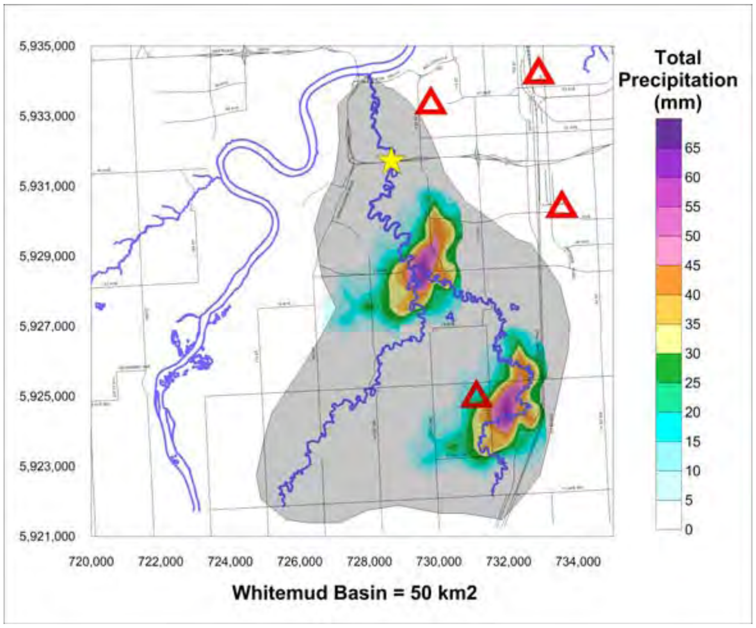

Figure 2: Whitemud Creek Basin

In order to size the culvert, hydrologic and hydraulic simulations would be completed using IDF data from the rainfall gauge located within basin, assuming it is available. Flows passing through the culvert are directly influenced by all rainfall falling within the catchment area. Using as visual reference the scaled features shown in Figure 2, including the total rainfall from two hypothetical convective rain cells, three key observations can be established:

1. Rain gauges proportionally record only a very small footprint of any given storm event while basins often experience a significant portion, if not all of the total storm rainfall.
2. The probability that a rain gauge will ever record the maximum total storm rainfall is very small while basins will often experience the entire extent of the storm including the peak rainfall.
3. Basins will occasionally experience multiple closely occurring convective storm cells (in time and space) within the same flow event while the probability that rain gauges ever capture the maximum of these multiple rain peaks is also very small.

As a result, rain gauge rainfall statistics always underestimate the maximum spatial rainfall input to watersheds. Considering that the sizing of various drainage structures like culverts are based on maximum flows for given durations and frequencies, the designed dimensions are also undersized for any given level of service. Similarly, the so-called conservative approach of uniformly applying rain gauge IDF statistics across the entire basin generally leads to underestimating rainfall input. It is clear that storm-based rainfall statistics are needed rather than rain gauge statistics in order to address the disparities of scale.

In order to generate storm-based rainfall statistics such as storm extent and maximum total rainfall, a totally different observation platform is required – one that can globally observe the entire genesis of each storm event. Fortunately, weather radars satisfy this requirement with a relatively high sampling interval (5-10 minutes) and adequate spatial resolution of 1 km^2. The realizations of the above-noted IDF limitations and the availability of an enabling technology convinced the City of Edmonton to sponsor research into developing spatial rainfall storm characteristics using weather radar. Since the initial mandate in 2002, the research has far exceeded its original objectives and has eventually led to formulating alternative "Design Storm" methodologies for use in water resources applications. This series of four articles summarizes key study findings.

Rainfall Storm Database

A major task of the study was the creation of a database containing a series of general data attributes that would serve as the principal source of information to determine the spatial-temporal characteristics of rainfall storms. The process of creating the Storm Database consisted of two main steps:

1. Creation of a Rainfall Database.
2. Identification of rainfall storm events and creation of Rainfall Storm Database.

Rainfall Database

The current version of the Rainfall Database consists of a single format, calibrated weather radar database with all storms from 1998 to 2009. However, plans are already under way to further expand the period of record to 2012 – a total of 15 years of data.

In order to create this Rainfall Database, the available radar reflectivity and regional rain gauge data were retrieved from the corporate computer archives onto the production systems. The data actually covers only the months of May to September for the years 1998 to 2009. Most of radar data are 1.5 km radial Constant Altitude Plan Position Index (CAPPI) reflectivity products obtained from Environment Canada.

Figure 3, shown below, presents in a detailed flow chart the various tasks that were developed in order to create the Rainfall Database.

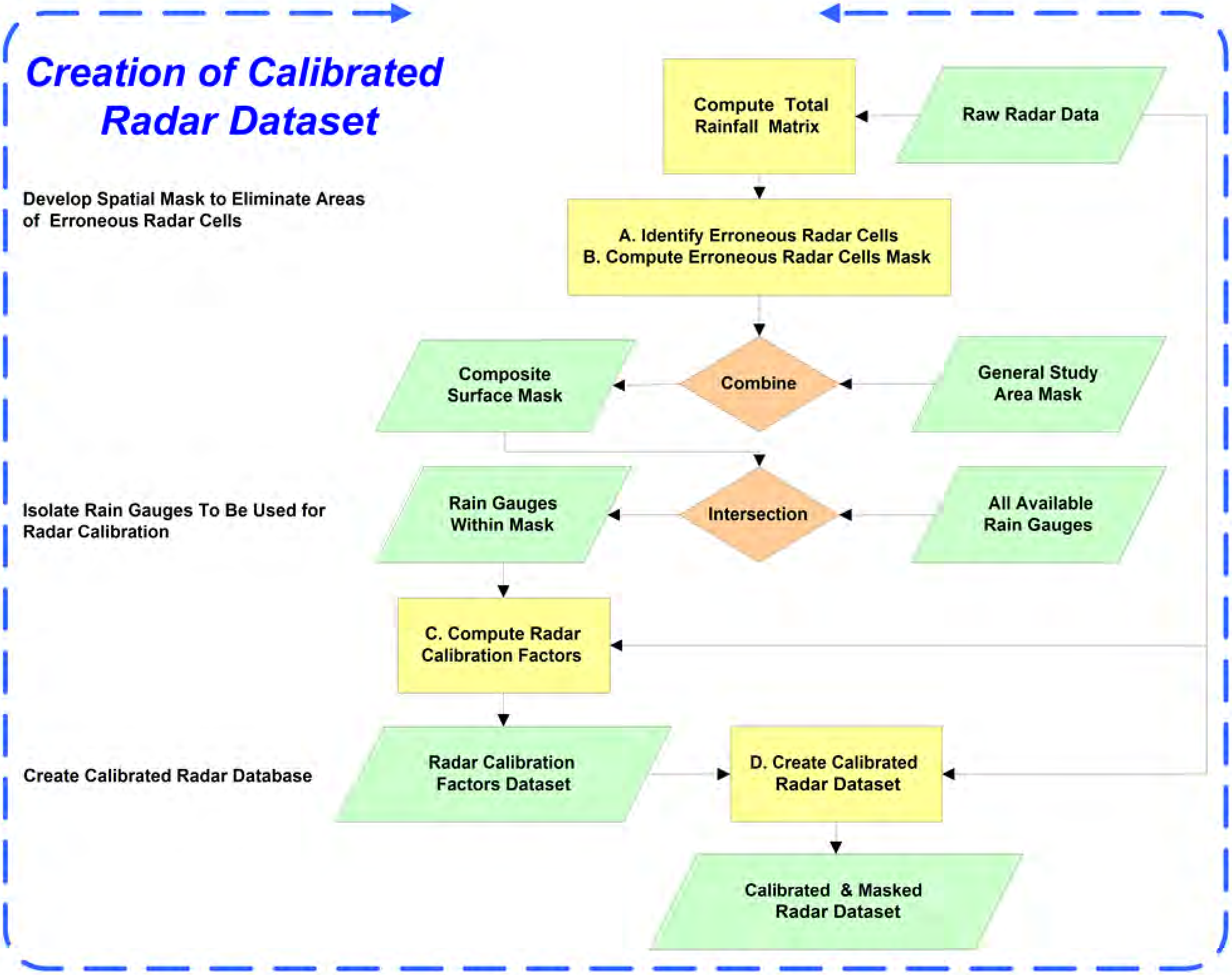

Figure 3: Tasks in Creating a Calibrated Radar Dataset

The tasks include:

1. Compute the total rainfall during the period of May to September for the available years of record.
2. Identify erroneous radar data cells within each year of database.
3. Create erroneous radar masks for each year of data.
4. Create a single rain gauge database for each year of data.
5. Compute radar – rainfall calibration factors using all appropriate rain gauges for the available years of record.
6. Compute calibrated radar-derived rainfall based on transforming the radar reflectivity data for all erroneous-free cells and all available years of record.
7. Populate the Rainfall Database by combining all the calibrated radar-derived rainfall data.

Study Area

The 120 km range of the Environment Canada's weather radar located near Carvel, Alberta was initially considered as the maximum extent describing a potential surface area of 45,200 km^2 for delineating the subject rainfall storm events. This radar is located approximately 50 km west of the City of Edmonton. The underlying premise of the study was that any storm within the study area has, for all practical purpose, the same spatial-temporal characteristics and could theoretically all occur over the City of Edmonton.

Considering the large potential surface area available for analysis, a conservative approach was used in identifying radar grid cells with erroneous data. As a first step, large tracks of recurring erroneous radar grid cells were identified and eliminated from further analyses. These generally included all areas in mountainous and hilly terrains. A second, more detailed process of identifying discrete erroneous radar grid cells was completed for each year of available radar data. This second process essentially consisted of the first three steps identified in Figure 3. Accordingly, the total precipitation (May to September, inclusive) was used to identify individual radar grid cells with very high and unrealistic values that were most likely due to ground clutters and spurious reflectivity. These specific radar grid cells were also removed from further consideration and were incorporated to form a composite radar mask combining all areas of concern. Consequently, a mask or filter, was created for each specific year of available radar data. Radar grid cells falling outside the masks comprised the actual useful study areas.

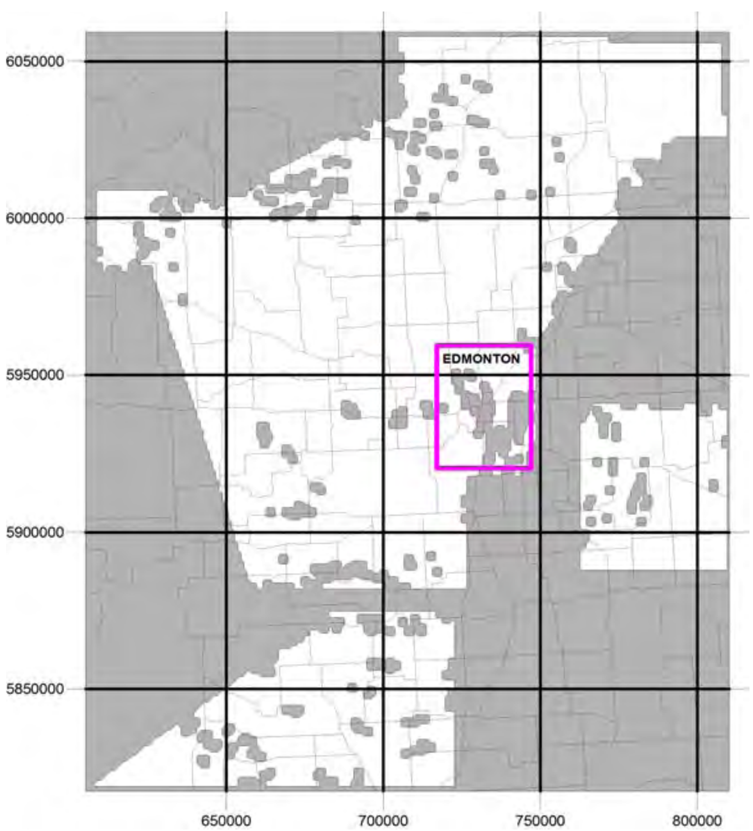

Figure 4: Radar Mask – 2004

Figure 4 shows the resulting composite radar mask that was used to process the 2004 radar reflectivity data in preparing that particular year's rainfall database. Areas in light grey were eliminated from further analyses. The figure also shows the City limits as a large rectangular with major roads in the background for ease of reference.

Note that Universal Transverse Mercator (UTM) geo-referencing grids were added to figure. A 50-km grid is shown on the figure. As stated earlier, radar grid cells falling within the grey areas were effectively filtered out and not used in subsequent analyses while the white areas were considered error-free.

Although a significant portion of the radar's total initial area is removed from further analyses, it is important to note that the remaining area still represents a very large territory that can easily contain storm entire rainfall events. Figure 5 lists the actual size of the study area that includes surfaces within the City of Edmonton as well as the surrounding lands for each year analyzed. The tabulation indicates a generally stable study area size with an average of 22,570 km^2 for the eleven years of available data. Note that the 2001 radar data was not available for analyses, but will be in the subsequent study.

Period of Analysis	Area (km^2)
1998 05-06	19,279
1998 07-09	23,451
1999	23,715
2000	24,768
2001	No Data
2002	23,065
2003	22,648
2004	23,406
2005	22,618
2006	21,475
2007	22,283
2008	19,994
2009	24,137

Figure 5: Study Area

Radar Data Processing

As previously mentioned, the source radar data used in the study is a set of 10-minute interval radial CAPPI reflectivity files created at 1.5 km in altitude. The first step in processing the radar data is to interpolate a 5-minute data file between each pair of contiguous 10 minute images in order to increase the volumetric accuracy and reduce the lateral shift errors associated with accumulating this type of data product. Unfortunately, this step doubles the already large radar database.

The second step is to create a 5-minute, 1 km^2 gridded rainfall intensity product that will serve as the principal source of uncorrected radar data. This is accomplished by populating the UTM grid cells using a closest neighbour approach with the standard Marshall-Palmer radar equation. The third and perhaps most important step in preparing the radar data for subsequent analyses are data adjustments using rain-gauge observations. The adjustments are completed in order to globally compensate for systemic radar errors and non-linearity issues associated with converting CAPPI radar reflectivity observations into ground-level rain estimates. This section briefly describes the radar adjustment procedures that were used for the study - as schematically presented in Figure 3.

The presence of hail within precipitating rain cells can cause erroneously high estimates of precipitation. This occurs because hail has a proportionately brighter - or higher - radar signature than rainfall. However, hail occurrences are usually highly localized and of short durations. Accordingly, a maximum 5-minute rainfall intensity value of 250 mm/hr was used as an upper limit on the precipitation rate. This limiting intensity value was used to mitigate the impact the "hail" in radar readings.

As previously stated, precipitation is an inherently chaotic phenomena - both in time and space. Turbulence within the precipitating clouds and other environmental factors can substantially alter the radar-derived spatial distribution and rates of precipitation as compared to ground observations. Generally, the greater the distance between the two planes (CAPPI altitude versus ground) the larger the potential discrepancies. Several methods of adjusting the radar data were available to the study team to address the technology's inherent limitations and are all based on using rain gauge observations. However, judgment must be exercised as to the validity of using any particular rain gauge data since erroneous rain gauge observations can negatively impact the end results.

A time-varying but spatially constant radar data adjustment method was used during the study. The method is based on computing and applying spatially constant adjustment factors ("**F**") to the radar data every 24 hours (midnight to midnight). Accordingly, radar adjustment factors were computed for each day of all years. The following relation was used to compute the radar adjustment factor that is the simple ratio of the total precipitation from all rain gauges to the sum of the precipitation value from the best radar grid cell within a three-by-three cell array about the radar grid cell that encompasses each rain gauge.

$$F_{3t} = \frac{\Sigma(P_{\text{Rain Gauge}})}{\Sigma(P_{3\ \text{Radar}})}$$

This approach, as opposed to using the radar values directly over each rain gauge, adds a degree of freedom that helps compensate for errors associated with: 1) gauge location to radar grid cell matching discrepancies and, 2) lateral movement of precipitation between the radar computational plane and the ground due to wind.

The available rain gauge records from Environment Canada and the City of Edmonton were used to compute the radar adjustment coefficients. Figure 6 shows the location of the pertinent rain gauges within the 2004 radar mask. The "+" symbols represent Environment Canada rain gauges, while the "X" symbols the City of Edmonton gauges. The 5-minute City of Edmonton rain gauge data was accumulated into daily values and appended to the Environment Canada daily rain gauge data (00:00 to 24:00) in order to create a single rain gauge database. The total number of available rain gauges varied from year to year as shown in Figure 7 resulting in an average of 22 gauges for each year of analysis.

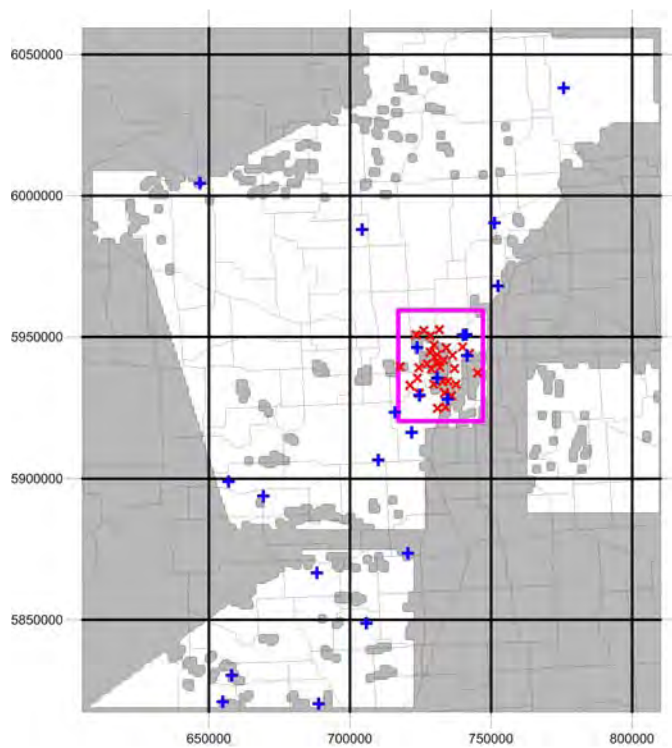

Figure 6: Location of Rain Gauge Used for Calibration – 2004 Mask

Eventually, a set of daily radar adjustment factors was computed for each year of available radar data based on using the available rain gauge with the masked radar reflectivity data plus a maximum 5-minute rainfall intensity of 250 mm/hr. Finally, the uncorrected radar data was adjusted with the daily adjustment factors to create the most accurate and error-free rainfall dataset. This radar dataset was ultimately used as the main data source for identifying and characterizing rainfall storm events.

As indicated in Figure 3, the last step is the creation of a calibrated Rainfall Database, was completed using the appropriate mask with the daily adjustment factors for the entire period of record. In order to eventually create a manageable storm database, the original time interval was increased from 5 to 15 minutes. Consequently, the final calibrated Rainfall Database consisted of 1km^2 UTM aligned radar grid cell matrices of 15-minute interval data. The matrices were compressed using a run-length encoding scheme in an effort to minimize storage requirements, but also to accelerate data access. The final calibrated rainfall dataset has currently more than 2 billion data points that serves as a database for identifying storm events and calculating related storm statistics.

Period of Analysis	Number of Rain Gauges
1998 05-06	19
1998 07-09	22
1999	22
2000	32
2001	No Data
2002	16
2003	22
2004	20
2005	23
2006	21
2007	23
2008	19
2009	28

Figure 7: Number of Rain Gauges Used for Calibration Purposes

Methodology for Identifying Storms

One of the study's most challenging steps was identifying and creating the rainfall storm database. This required a systematic aggregation of spatial-temporal voxels (1 km^2 by 15 minutes) according to a set of hydrometeorological criteria within trillions of data points into discrete storm entities. New and efficient computational methods were required and developed in order to produce the desired results in a timely fashion. This section will discuss the methodologies adopted by the study team that led to the creation of the storm database.

Storm events were identified using the main tasks presented in Figure 8 (shown on next page). Tasks are represented as rectangles while databases are shown as rhombuses. The process of identifying storm events is computationally intensive and essentially consists of two recursive steps:

1. For each time interval, spatially aggregate adjusted rainfall radar grid cells into contiguous rainfall aggregates according to a Hydrometeorological Criteria.

2. Link contiguous rainfall aggregates with other contiguous fragments from previous intervals.

The *Hydrometeorological Criteria* were established to ensure a consistent definition for identifying storm events, but - more importantly — to guide the automated process of aggregating individual radar rainfall grid cells into complete time/space storm entities. The *Hydrometeorological Criteria* are defined as:

1. Rainfall intensity per radar grid cell has to be equal or greater than 0.2 mm/hr.
2. Inter-event spatial spacing of equal or less than four radar grid cells (4 X 1 km^2).
3. Inter-event time of equal or less than 6 hours.

The first criterion must be satisfied before any given rainfall radar grid cell is accepted for the aggregation process. Radar grid cells that satisfy this minimum rainfall criterion are then assigned to the nearest rainfall aggregate according to proximity under Criteria 2 and 3. Should a rainfall radar grid cell fail the assignment process by exceeding Criteria 2 and 3, it is deemed to belong to a "new" rainfall aggregate.

This aggregation process continues in a step-wise fashion for the entire period of record. When aggregates of rainfall grid cells are no longer being added in time, the given rainfall aggregate is deemed to form a complete and discrete storm event. A set of multiple storm attributes are subsequently computed for each "complete storm event" and saved for subsequent analyses.

Rainfall Storm Database

Rainfall storm events were identified for all available years of radar data based on the methodology described in the previous section and subsequently characterized in terms of their spatial/temporal attributes to form two distinct storm databases:

1. **Main Storm Attribute Database:** A series of general statistics.

2. **Storm Spatial Attribute Database:** A series of spatial oriented themes.

The **Main Storm Attribute Database** consists of a relational structure based on "storm entities"; whereas, each record describes a unique rainfall storm event that was isolated from the previously described storm identification processes. There are currently over 25,500 storms of various sizes in the database. The database tables contain the following storm attributes:

- Unique storm identification number based on the rainfall start date
- Start and end date/times
- Duration (beginning of rain to end of rain, anywhere within storm area)
- Maximum storm areal extents
- Cell with maximum total rainfall (RMax) and its location
- Rainfall duration at cell with maximum total rainfall
- Return period at cell with maximum total rainfall

- Cell with maximum rainfall intensity and its location
- Total volume of rainfall
- Maximum surface area experiencing rainfall
- Average rainfall (Volume divided surface area)
- Average movement direction and speed
- Total storm movement

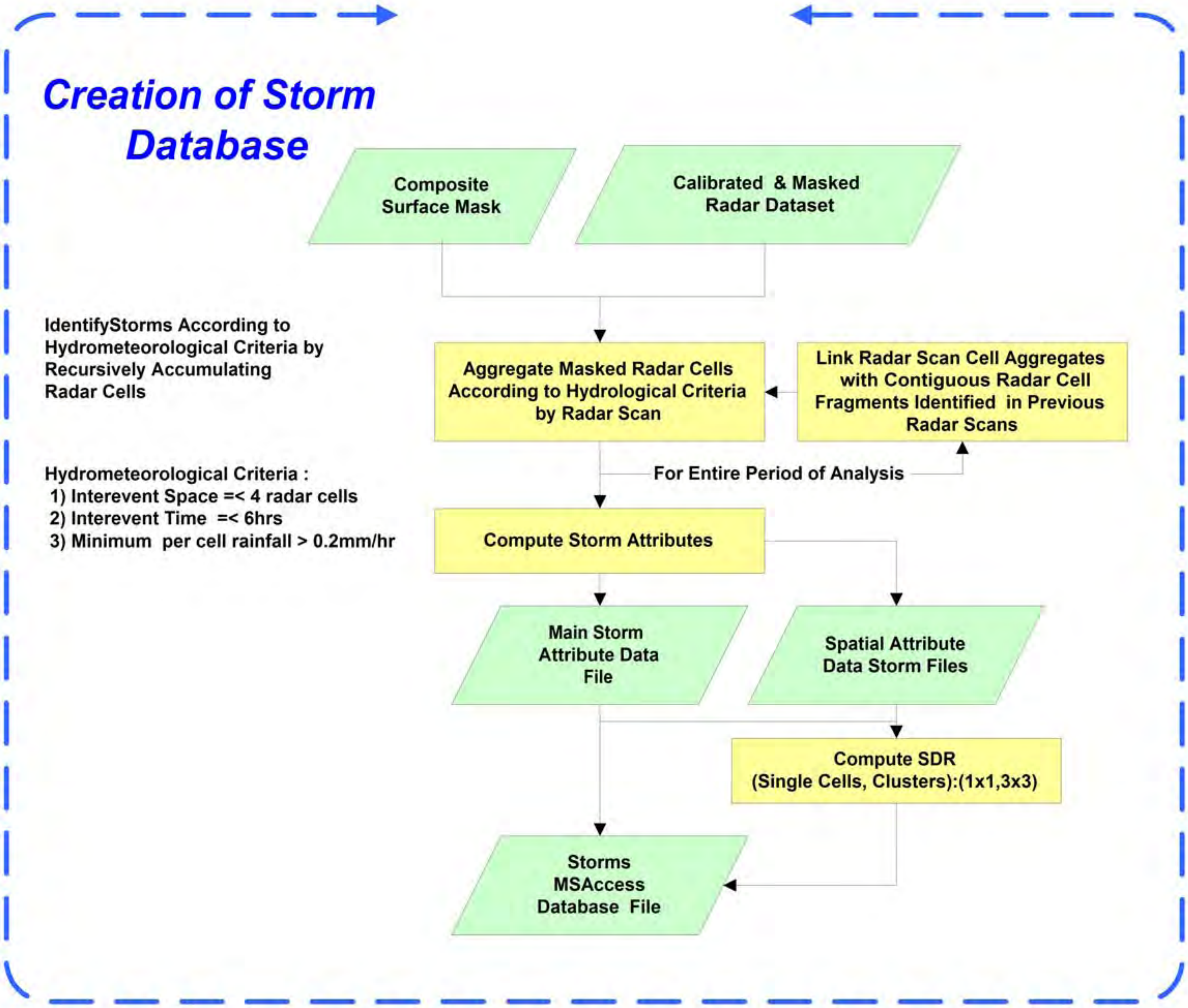

Figure 8: Creating the Storm Database

For every storm, Spatial Decay Ratios (SDRs) were computed for every maximum rainfall radar grid cell with a total rainfall greater than 20 mm. Essentially, SDRs are a series of points representing the spatial decay of the maximum rainfall totals as a function of rain surface area. Each rainfall storm event typically includes many storm cells. It is not surprising to find that the database currently contains over 1,200,000 SDR records. Each SDR record is described by several attribute fields including:

- Relative and absolute coordinates of the grid cell with the maximum total rainfall
- Identifier for the type of method used in deriving the SDR data points:
  - S1 = single (1X1 matrix)
  - S3 = single (3X3 matrix)
  - C1 = cluster (1X1 matrix)
  - C3 = cluster (3X3 matrix)
- Duration of rainfall at point of maximum total rainfall
- Type of storm cell:
  - SCC = single convective cell
  - SCF = single cell in frontal system
  - CLCC = cluster of convective cells
  - CLCF = cluster of convective cells in frontal system

The latter attribute was identified manually by reviewing the total precipitation map patterns.

A series of at least three points are required to describe each SDR curve. These points are stored in a separate database table currently holding over 4.5 million data points. This table also has a few other attribute fields including:

- Surface area covered by SDR point
- Total rainfall over surface area
- SDR value

Each storm is also characterized spatially by a set of five thematic maps that together form the **Storm Spatial Attribute Database**. Each thematic map is essentially a matrix of 1 km^2 grid point storm values describing:

- Total rainfall
- Maximum rainfall intensity
- Duration
- Total rainfall return period
- Maximum rainfall intensity return period

Conclusions

This first of four papers has presented the impetus and study objectives as well as the processes used in developing a comprehensive database of rainfall storms for subsequent analysis. Storm-based statistics, rather than point-based rain gauge statistics (i.e. IDF data), are required in order to develop a more rigorous approach to computing rainfall inputs for designing the water resources infrastructure.

A large storm database was created by successfully applying hydrometeorological criteria to a multi-year database of radar-derived precipitation database. All computed storm event attributes are described at a 1-km^2 and 15-minute interval and stored in a relational database or, in a discrete set of thematic raster files. The database currently contains over 25,500 storm events that were observed over an average study area of approximately 22,250 km^2 and a period of record of 11 years.

Three subsequent papers will present the analyses results including general and advanced storm characteristics as well as an alternative Design Storm Method to the currently-used IDF approach.

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WMO Update on EL NIÑO / LA NIÑA

Current Situation and Outlook

Neutral conditions (neither El Niño nor La Niña) continue in the tropical Pacific. Model forecasts and expert opinion suggest that the likelihood of El Niño or La Niña conditions developing during the first half of 2013 is low, and that neutral conditions are likely to be maintained through the boreal spring. National Meteorological and Hydrological Services and other agencies will continue to monitor Pacific Basin conditions and provide outlooks to assess the most likely state of the climate through the coming several months of 2013.

Situation actuelle et perspectives

Des conditions neutres (ne correspondant ni à une anomalie El Niño, ni à une anomalie La Niña) persistent dans le Pacifique tropical. D'après les prévisions des modèles et les interprétations des experts, l'apparition d'un épisode El Niño ou La Niña durant le premier semestre de 2013 est peu probable, et des conditions neutres devraient persister jusqu'à la fin du printemps boréal. Les Services météorologiques et hydrologiques nationaux ainsi que d'autres organismes continueront de suivre de près la situation dans le bassin du Pacifique et de dégager des perspectives d'évolution, afin de déterminer le scénario climatique le plus probable pour les mois à venir.

During the last 10 months El Niño-Southern Oscillation (ENSO) indicators in the tropical Pacific (e.g., tropical Pacific Ocean temperatures, sea level pressure, cloudiness and trade winds) have generally been at neutral levels, indicating neither El Niño nor La Niña conditions have been present. From July to October 2012, sea surface temperatures increased to a borderline El Niño level, but the atmospheric characteristics of El Niño failed to develop and the ocean-atmosphere system as a whole remained in a neutral state. Since November the tropical Pacific Ocean has cooled, and although the first two months of 2013 showed patterns of ocean temperatures that approached borderline La Niña levels, and cloudiness and trade winds that also leaned towards La Niña conditions, the tendency has been weak and the state of the ocean-atmosphere system as a whole continued to be neutral.

The latest outlooks from climate models and expert opinion suggest that sea surface temperature and atmospheric anomalies are most likely to remain neutral through the boreal spring of 2013. Less than a quarter of models surveyed predict borderline or weak La Niña conditions during the February to April period, but nearly all models clearly display neutral conditions by early boreal spring. No model predicts El Niño development during the period of March to May 2013. Forecasts beyond the boreal spring made at this time of the year have lower levels of skill than outlooks made at other times; hence users should factor this into their risk assessments.

It is important to note that El Niño and La Niña are not the only factors that drive global climate patterns. At the regional level, seasonal outlooks need to assess the relative impacts of both the El Niño/La Niña state and other locally relevant climate drivers. Such other factors may include, for example, conditions in the tropical Indian and Atlantic oceans, as these can influence surrounding continental climate patterns. Locally applicable information should therefore be consulted in detailed regional/national seasonal climate outlooks, such as those produced by WMO Regional Climate Centres (RCCs), Regional Climate Outlook Forums (RCOFs) and National Meteorological and Hydrological Services (NMHSs).

In summary:

1) Since April 2012, conditions have remained neutral in the tropical Pacific (neither El Niño nor La Niña);

2) Since January 2013 tropical Pacific Ocean temperatures and some atmospheric features have leaned toward La Niña conditions, but the overall ocean-atmosphere system has remained neutral;

3) As of late February 2013, outlooks indicate that neutral conditions are likely to continue through the boreal spring, after which the outlook is uncertain due to characteristically low outlook confidence at this time of the year.

The situation in the tropical Pacific will continue to be carefully monitored. More detailed interpretations of regional climate fluctuations will be generated routinely by the climate forecasting community over the coming months and will be made available through the National Meteorological and Hydrological Services. For web links of the National Meteorological Services, please visit:

http://www.wmo.int/pages/members/members_en.html

Source: WMO Press Release # 968, March 11, 2013.

The World Meteorological Organization is the United Nations System's authoritative voice on Weather, Climate and Water.

Return to 2012 - Runner-Up Weather Stories for the Past Year[1]

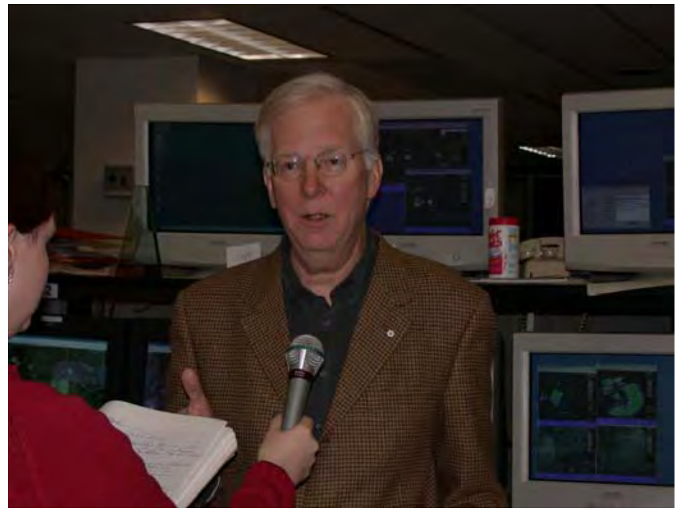
by David Phillips[2]

Winter's Last Hurrah in the East

After an unseasonably warm start to spring, Eastern Canadians were shocked when a nasty spring storm in the final week of April brought rain, snow, ice pellets, freezing rain and strong cold winds. An intense and moisture-laden system raced up the United States eastern seaboard, curved northwestward into eastern Ontario and Quebec, and then spread its canopy of wintry precipitation into Atlantic Canada. In parts of southern Ontario, the slushy surprise crushed early blooms and nipped blossoms while snowfall on elevated terrain reached 30 cm. The snow, combined with high winds, produced hazardous driving conditions, with blowing snow cutting visibility to nil in many areas. In Montreal, the storm dumped 25 to 40 mm of heavy rain, while the Laurentians and Mont-Tremblant saw a combination of 15 to 25 mm of rain and 10 to 15 cm of snow and ice pellets. Hydro-Québec reported more than 28,000 customers were without power. In the Maritimes, it was all rain including: 116 mm in Saint John; 94 mm in St. Stephen; 86 mm in Fredericton; 56 mm in Yarmouth; and 79 mm in Brier Island.

$100 Million Storms Across Ontario and Quebec

A series of severe thunderstorms raked parts of southern and eastern Ontario and western Quebec during the third week of July inflicting $100 million in property losses. Heavy downpours combined with hail and fierce winds to bring down trees and power lines, rip away roofs, dent vehicles and house siding, and trigger flash floods. Close to 30,000 hydro customers in eastern Ontario and another 70,000 in Quebec lost service during and after the storms. Many people welcomed the wet weather after weeks of hot and dry conditions, but the highly localized and intense downpours were not quite the rains hoped for. On July 22, the Hamilton International Airport weather station recorded 66 mm of rain although an unofficial gauge recorded 140 mm of rain. The next day, more hot and sticky air with a passing cold front triggered another round of thunderstorms across the region. During the late morning hours, there were several reports of tree damage in communities north of Lake Nipissing and towards Mattawa. In the afternoon, the storms spawned additional bursts of damaging winds through Renfrew County in and around the community of



David Phillips with Media

Calabogie. Most damage was caused by straight-line winds associated with intense downburst winds of 110 km/h. Despite rumours, there was no evidence of a tornado touchdown. Golf-ball-sized hail dimpled the hoods and roofs of hundreds of cars, broke windows and shattered side mirrors. At local campgrounds, countless trees were uprooted and several boats and trailers flipped over. With the long storm path extending through a large expanse of woodlands, winds felled tens of thousands of trees. Luckily no serious injuries were reported. The severe thunderstorms crossed into Quebec bringing strong winds, hail 4 cm in diameter and rainfall rates between 50 and 100 mm/h. The storms inflicted significant property damage, especially in Montérégie and the Laurentides. Nearly 70,000 Quebec properties were left without electricity. Rounding out the week, 30,000 bolts of lightning triggered nighttime fires at homes and rural outbuildings between London and Toronto on July 25 causing extensive damage.

Early Start to Forest Fire Season

According to the Canadian Interagency Forest Fire Centre, the number of wildfires in Canada exceeded 6,400 or twice the total last year and higher than any average for 5, 10, 20 or 25 years. On the other hand, total hectares of consumed forest weighed in less than in 2011 but close to 10- and 15-year averages. With an unusually warm and dry winter-spring across Canada, fire fighters were put on guard much earlier in 2012.

At the beginning of March, Alberta's forest floor was dangerously dry and free of snow prompting the province to declare an early start to the fire season. By mid-May, forests north of Edmonton were bone dry, humidity was low and winds were strong and gusty, raising the wildfire threat from high to extreme. Soon after, fire-breeding conditions triggered a sweeping fire ban across most of the province's forests – from Waterton Lakes National Park in the south to north of Fort McMurray. Across northeastern Ontario, May's hot, dry and windy weather also led to an early start to the

[1] Note: Excluding the story on the Return of West Nile Virus. Presented in chronological order.

[2] Senior Climatologist, Meteorological Service of Canada, Environment Canada, Downsview, Ontario, Canada

fire season. By the Victoria Day weekend, dangerous hot spots were popping up everywhere with the largest fire burning near Kirkland Lake. On May 25, another wildfire spewed choking smoke and falling ash on the outskirts of Timmins. Officials declared a state of emergency and started evacuating 800 residents from cottages, campgrounds and camps surrounding the city. Strong winds impeded efforts to douse the flames and pushed the heavy haze closer to Timmins before shifting winds two days later eased the threat. In New Brunswick, unusually dry conditions meant the province's Forest Fire Watch began two weeks earlier than scheduled. Continued drying into July increased the number of grass fires. In total, fire starts in the province were above both the 10-year and 20-year averages and exceeded burned hectares over the last 10 years. Further east, hot and dry weather heightened the forest fire threat throughout Newfoundland and Labrador. On June 23, more than 1,800 people from two Labrador communities north of Goose Bay were ordered to evacuate due to advancing flames. Province-wide, 192 wildfires burned 137,000 hectares of woodland in 2012 compared to the 20-year average of 114 fires and 28,000 hectares, respectively.

After months of relative quiet, authorities in British Columbia began seeing numerous fires spring up following the onset and persistence of hot dry weather between mid-July and October. On September 9, a fire started on the outskirts of Peachland in the Okanagan Interior. Strong winds caused it to spread rapidly, destroying four homes. About 1,500 families and businesses were under an evacuation order as a veil of thick white smoke and ash blanketed one-third of the community. In total, British Columbia had 17 per cent more fires than normal in 2012 but burnt wildland was less than average.

Glorious BC Summer Book-ended by Wetness

Grey skies and cool-wet conditions dominated the weather across British Columbia through spring and early summer, especially in June (a.k.a. Juneuary), leaving some residents wondering if the sun would ever show up. It didn't help that the East was boasting a non-winter, March mildness and the early arrival of a hummer summer. When summer did officially arrive on the Pacific Coast its first days offered up more of the same leaden skies and damp streets. Weather-suffering residents grew frustrated then resigned as the wet weather continued over the Canada Day long weekend. The prolonged overcast had a detrimental effect on outdoor recreation. Gardeners spent their time battling slugs. And some farmers had to replant seeds that simply failed to germinate due to the damp or cold, or both. Crops that did take experienced delayed development by two to three weeks, especially strawberries and blueberries. A steady occurrence of North Pacific weather seemed to nail Vancouver Island and the Lower Mainland day after day. In Victoria, between May 20 and June 18, 23 of 30 days were wet. And this was supposed to be the dry season. In Vancouver, no records were set in June but the statistics were depressing: more rain (40 per cent higher than average with 19 wet days); lower temperatures; and far less sunshine than average (only 157 hours in total and six days with nary a minute of sunshine).

In British Columbia, it is said that patience with June gloom will be rewarded with a glorious summer. Many of those same people believe September is the nicest month along the Pacific Coast. Both proved true in 2012 with spectacular warm dry weather that stretched from early July to the second week of October. August and September went down in history as the driest in 105 years in Vancouver with a paltry 5.9 mm of rain (7 per cent of normal). In addition, temperatures soared into the high 20s and beyond, setting records across the province. And there was no shortage of sunshine. The delightfully monotonous weather was thanks to a strong persistent ridge of high pressure that stayed over the province, encouraging a southerly flow with clear skies and record warm temperatures that effectively blocked any storms from reaching the coast. Victoria and Nanaimo also experienced their driest August to September on record. Victoria had just 3.8 mm of rain in those months – less than the previous record of 5.0 mm in 1974. In that same period, Nanaimo saw 7.0 mm compared with 9.1 mm in 1998. The prolonged dryness put several coastal communities under severe water restrictions. Drastically reduced water levels on the Cowichan River on Vancouver Island adversely affected returning salmon, drinking water supplies and sewage dilution, and forced temporary job losses at paper and pulp mills. There was real concern that the Cowichan River would dry up if it didn't start raining soon.

During a near weather-perfect 100 days between July 3 and October 9 the sun shone on every day but three. The "non-weather" stretch pleased the province's winemakers anticipating a banner vintage with high sugar levels. In the northeast at Fort St. John, barely 1.0 mm of rain fell in September, far below the record low of 15.4 mm in 2006 and well off September's monthly average of 45.7 mm. Rivers across most of Peace River country edged toward historic lows, prompting a low streamflow advisory for the eastern Peace and a suspension of short-term water withdrawals from area rivers for oil and gas operators.

On October 13, Vancouver's 11-week dry spell came to an end. And when it started to rain, it poured, heralded by strong winds with gusts measuring 158 km/h along the coasts. In 27 days following October 11, 236 mm of rain fell in Vancouver with only 2 dry days; the same period prior to October 12 had 2 wet days and a total of 2.0 mm of rain.

From Fire to Ice in Manitoba

There was little to be thankful for in southeastern Manitoba the week before Thanksgiving as the region experienced a range of weather extremes that included wildfires, heavy snow drifts and paralyzing freezing rain. It started with residents in Vita, St. Malo and surrounding communities being forced to flee when grass and bushfires fuelled by strong, warm and dry winds destroyed several buildings and a bridge. Some people resorted to soaking down trees and grass on their properties to prevent flames from spreading. Despite these efforts, four families lost their homes to the fires. Two days later, a winter storm walloped the region and put a quick end to the stubborn flames. On the down side, it also dumped up to 30 cm of heavy, wet snow that resulted in road closures and power outages in a dozen communities. Travel along the Trans-Canada Highway and other roadways was severely restricted with poor visibility from blowing snow as a result of north winds that gusted up to 70 km/h. Adding to the misery was ice 8 cm thick that coated power lines and trees, felling 165 hydro poles and one hydro tower. As utility crews struggled to reach downed lines, up to 6,000 people were left in the dark. In the Interlake region, gusting winds pushed water from Lake Winnipeg into the streets of Gimli.

Record Snows on the Prairies

A couple of powerful weather systems originating south of the border lingered across the Prairies for five days before Remembrance Day. The early bout of winter created misery for motorists and pedestrians from the foothills of the Rockies to northwestern Ontario. The first storm formed over Idaho and Montana on November 7 and travelled north into Alberta. It began as freezing rain in Edmonton but changed quickly to heavy wet snow (30 cm), wreaking havoc on roads and forcing schools to close. Calgary and the rest of southern Alberta also got pounded with 20 to 30 cm of snow. Two days later, a storm from Colorado infused with moisture from the Gulf of Mexico arrived over Saskatchewan and Manitoba. Swirling snow powered by strong cold winds created treacherous driving conditions causing hundreds of collisions across southern and central parts of both provinces. People struggled as they shovelled out from 25 to 40 cm of snow whipped by winds gusting to 50 km/h.

Between November 9 and 11, Regina was covered in 34 cm of snow. The bulk of it – 24 cm – fell on November 9, setting a new daily record. With the official start of winter still a month away, Regina residents were already exhausted from clearing record amounts of snow. In the first three weeks of November, the Queen City received more snow than fell during six months of winter last year. By month's end, Regina had experienced its snowiest November since record-keeping began in the 1880s. But while city dwellers may have been exhausted, farm folk were exhilarated because the wet snow helped to ease low moisture levels from too many weeks of scanty precipitation.

A change of months did not change the weather. In early December, another storm packing more freezing rain and snow raced across the Prairies bringing hazardous driving conditions along the Trans-Canada Highway. Conditions were also treacherous between Edmonton and Saskatoon. Inter-provincial transportation came to a halt for several hours. The intense winter storm brought only snow to parts of central Manitoba but still made a mess with knee- to waist-deep loads blown into two-metre drifts. Some locations received 40 to 90 cm of snow, breaking their one-day records. Just a few days later, on December 5, another 15 cm of snow fell in Edmonton reducing visibility and snarling traffic yet again. Prairie residents were getting winter-weary, yet the start of the season was still more than two weeks away.

Note from the Editor: Runner-up stories are weather events that were considered, evaluated and rated but did not quite make it to the top 10 weather events list of the year.

Retour sur 2012 - Finalistes des événements marquants de l'an passé[3]

by David Phillips[4]

Le dernier passage de l'hiver dans l'Est

Après un début de printemps exceptionnellement chaud, les Canadiens de l'Est ont été étonnés lorsqu'une énorme tempête a apporté de la pluie, de la neige, des granules de glace, de la pluie verglaçante et des vents froids et forts au cours de la dernière semaine d'avril. Un système intense et chargé d'humidité a remonté rapidement la côte est des États-Unis, a infléchi sa trajectoire vers le nord-ouest pour atteindre l'est de l'Ontario et le Québec et a ensuite étendu son couvert de précipitations hivernales dans le Canada atlantique. Dans certaines régions du sud de l'Ontario, cette surprenante neige fondante a écrasé les floraisons hâtives et a tué les bourgeons, tandis que les chutes de neige sur les terrains élevés ont atteint 30 cm. La neige, combinée aux vents forts, a produit des conditions routières dangereuses, la poudrerie rendant la visibilité nulle dans de nombreuses régions. À Montréal, la tempête a déversé de 25 à 40 mm de pluies abondantes, alors que les Laurentides et Mont-Tremblant ont enregistré une combinaison de 15 à 25 mm de pluie et de 10 à 15 cm de neige et de granules de glace. Hydro-Québec a signalé que plus de 28 000 clients se sont retrouvés sans électricité. Dans les Maritimes, il y avait de la pluie partout, notamment 116 mm à Saint John, 94 mm à St. Stephen, 86 mm à Fredericton, 56 mm à Yarmouth et 79 mm sur l'île Brier.

Des orages causent 100 millions de dollars de dégâts en Ontario et au Québec

Une série d'orages violents a balayé des régions du sud et de l'est de l'Ontario et de l'ouest du Québec au cours de la troisième semaine de juillet, causant 100 millions de dollars de pertes matérielles. Les pluies torrentielles combinées à

[3] Note: Le retour du virus du Nil occidental est exclus de cette présentation. Présentation par ordre chronologique.

[4] Climatologue principal, Service Météorologique du Canada, Environnement Canada, Downsview, Ontario, Canada

de la grêle et à des vents violents ont fait tomber des arbres et des lignes électriques, arraché des toits, cabossé des véhicules et des parements de maisons et déclenché des crues éclair. Pendant et après les tempêtes, près de 30 000 clients d'Hydro One de l'Est de l'Ontario ont subi des pannes de courant, tout comme 70 000 clients d'Hydro-Québec au Québec. De nombreuses personnes se sont réjouies de l'arrivée de cette pluie après plusieurs semaines de temps chaud et sec, mais les précipitations très intenses et localisées ne répondaient pas aux attentes. Le 22 juillet, la station météorologique de l'aéroport international de Hamilton a enregistré 66 mm de pluie, bien qu'un instrument de mesure non officiel ait enregistré 140 mm de pluie. Le jour suivant, une autre masse d'air chaud et collant rencontre un front froid, déclenchant une autre série d'orages dans l'ensemble de la région. En fin de matinée, plusieurs dommages causés aux arbres étaient signalés dans des collectivités situées au nord du lac Nipissing et vers Mattawa. Dans l'après-midi, la tempête a engendré d'autres rafales destructrices dans le comté de Renfrew, plus précisément dans la collectivité de Calabogie et aux alentours. La plupart des dommages ont été causés par des vents rectilignes associés à d'intenses rafales atteignant 110 km/h. Malgré les rumeurs, aucune indication n'a confirmé qu'une tornade ait touché le sol. Des centaines de voitures ont été détériorées par des grêlons de la taille de balles de golf : toits et capots bosselés, vitres et rétroviseurs brisés. Sur les terrains de camping, d'innombrables arbres ont été déracinés et plusieurs bateaux et caravanes, renversés. Étant donné que la longue trajectoire de tempêtes s'étendait sur une vaste zone forestière, les vents ont abattu des dizaines de milliers d'arbres. Heureusement, aucune blessure grave n'a été signalée. Les orages violents ont traversé le Québec produisant de forts vents, des grêlons de 4 cm de diamètre et des précipitations d'une intensité allant de 50 à 100 mm/h. Les tempêtes ont engendré d'importants dommages matériels, particulièrement en Montérégie et dans les Laurentides. Près de 70 000 propriétés au Québec ont été privées d'électricité. Et pour couronner la semaine, le 25 juillet, 30 000 éclairs ont provoqué des incendies nocturnes touchant des habitations et des dépendances rurales entre London et Toronto, causant ainsi d'importants dégâts.

Début hâtif de la saison des feux de forêt

Selon le Centre interservices des feux de forêt du Canada, plus de 6 400 incendies sont survenus au pays, soit deux fois plus que l'an dernier; ce nombre est supérieur à toutes les moyennes sur 5, 10, 20 ou 25 ans. Cependant, le nombre total d'hectares de forêt ravagés a été moindre qu'en 2011, mais s'est néanmoins situé près des moyennes sur 10 et 15 ans. L'hiver et le printemps ayant été inhabituellement doux et secs partout au Canada, les pompiers ont été mis sur un pied d'alerte plus tôt en 2012.

Au début de mars, le tapis forestier de l'Alberta, dangereusement sec et sans neige, a motivé la province à décréter le début de la saison des incendies beaucoup plus tôt qu'à l'habitude. Dès la mi-mai, les forêts extrêmement sèches au nord d'Edmonton, l'humidité faible et les vents soufflant en fortes rafales, le niveau de menace de feux de forêt passait d'élevé à extrême. Peu de temps après, les conditions étant propices aux incendies, on décrétait une interdiction de faire des feux dans la plupart des forêts de la province, du sud du parc national du Canada des Lacs-Waterton jusqu'au nord de Fort McMurray. En mai, partout dans la région du nord-est de l'Ontario, le temps chaud, sec et venteux a également mené au décret hâtif de la saison des feux. Déjà, dès la fin de semaine de la fête de Victoria, de dangereux points chauds étaient signalés partout, la plus grande concentration se trouvant près de Kirkland Lake. Le 25 mai, un autre feu de forêt se déclarait, répandant sa fumée et ses cendres à la périphérie de Timmins. Les autorités décrétaient alors un état d'urgence et le début de l'évacuation de quelque 800 personnes occupant les chalets, les terrains de camping et les campements dans les alentours de cette ville. Les vents forts entravaient les efforts pour éteindre les flammes et dirigeaient la lourde fumée près de Timmins, avant de tourner deux jours plus tard et que la menace soit apaisée. Au Nouveau-Brunswick, les conditions exceptionnellement sèches ont justifié le déclenchement de la surveillance des feux de forêt deux semaines plus tôt que prévu. La sécheresse s'est poursuivie jusqu'en juillet, augmentant le nombre de feux de broussailles. En tout, les débuts d'incendie dans la province dépassaient la moyenne sur 10 et sur 20 ans, brûlant un nombre d'hectares plus élevé qu'au cours des dix dernières années. Plus à l'est, le temps chaud et sec a exacerbé la menace des feux de forêt partout à Terre Neuve et Labrador. Le 23 juin, plus de 1 800 personnes dans deux collectivités du Labrador, au nord de Goose Bay, recevaient un ordre d'évacuation en raison de la progression des flammes. Dans toute la province, 192 incendies ont rasé 137 000 hectares de terrains boisés en 2012 par rapport à la moyenne sur 20 ans de 114 incendies et de 28 000 hectares.

Après des mois de calme relatif, les autorités de la Colombie-Britannique constataient l'apparition de nombreux incendies, après qu'un temps chaud et sec se soit installé et ait persisté de la mi-juillet jusqu'à octobre. Le 9 septembre, un incendie se déclarait dans la périphérie de Peachland, dans la région d'Okanagan Interior. De forts vents ont fait en sorte qu'il s'étende rapidement, détruisant quatre résidences. Environ 1 500 familles et entreprises ont fait l'objet d'un ordre d'évacuation, en raison d'une épaisse fumée blanche et de cendres qui recouvraient un tiers de la collectivité. Au total, le nombre d'incendies en Colombie Britannique a été de 17 % supérieur à la normale en 2012, mais le nombre de terres brûlées moindre que la moyenne.

L'humidité clôt le dernier chapitre d'un magnifique été en Colombie-Britannique

En Colombie-Britannique, le temps a été dominé par un ciel gris et des conditions de fraîcheur et d'humidité au printemps et au début de l'été, en particulier en juin (appelé pour l'occasion « juinvier »); certains résidents se sont donc demandé si le soleil allait un jour faire son apparition. Un hiver absent, la douceur en mars et l'arrivée précoce d'un été décevant dans l'Est ont contribué à ces conditions. Lorsque l'été est officiellement arrivé sur la côte du Pacifique, ses premiers jours ont poursuivi la tendance : ils ont été gris et humides. Les résidents subissant ces conditions étaient de plus en plus frustrés, puis se sont résignés lorsque le temps humide a persisté pendant la longue fin de semaine de la fête du Canada. La longue période de ciel couvert a eu un effet néfaste sur les activités de plein air. Les jardiniers ont passé leur temps à combattre les limaces. Certains agriculteurs ont dû planter de nouvelles graines qui n'ont pas réussi à germer à cause de l'humidité ou du froid (ou des deux). La croissance des cultures qui ont pu germer a retardé de deux à trois semaines, en particulier celle des fraises et des bleuets. La persistance des conditions météorologiques du Pacifique Nord a semblé condamner l'île de Vancouver et la région du Lower Mainland en Colombie-Britannique. À Victoria, entre le 20 mai et le 18 juin, 23 jours sur 30 ont été pluvieux. Et cela était censé être la saison sèche. À Vancouver, aucun record n'a été établi en juin, mais les statistiques étaient déprimantes : davantage de pluie (40 % de plus en moyenne avec 19 jours pluvieux), des températures plus basses, et beaucoup moins d'ensoleillement qu'en moyenne (seulement 157 heures au total et six jours avec à peine une minute d'ensoleillement).

En Colombie-Britannique, on dit que la patience lors d'un mois de juin morose sera récompensée par un magnifique été. Nombre de ces personnes qui croient à cette logique pensent que septembre est le plus beau mois sur la côte du Pacifique. Les deux faits se sont avérés exacts en 2012 avec une période de temps chaud et sec spectaculaire qui s'est étendue du début du mois de juillet à la deuxième semaine d'octobre. Les mois d'août et de septembre sont passés dans l'histoire comme étant ceux les plus secs en 105 ans à Vancouver, avec une quantité dérisoire de 5,9 mm de pluie (7 % de la quantité normale). En outre, le mercure a frôlé les 30 degrés et plus, établissant des records dans toute la province. Et il n'y a pas eu de pénurie de soleil. Les conditions délicieusement monotones étaient dues à une forte crête de haute pression persistante qui est restée au dessus de la province, encourageant un flux en direction du sud avec un ciel clair et des températures chaudes records qui ont efficacement empêché toute tempête d'atteindre la côte. Victoria et Nanaimo ont également connu leurs mois d'août et de septembre les plus secs jamais enregistrés; Victoria a reçu seulement 3,8 mm de pluie soit moins que le record précédent de 5 mm en 1974. Lors de cette même période, Nanaimo a reçu 7 mm de pluie par rapport à 9,1 mm en 1998. La sécheresse prolongée a placé plusieurs collectivités côtières sous restriction d'eau sévère. Des niveaux d'eau très réduits de la rivière Cowichan sur l'île de Vancouver ont nui aux montaisons de saumon, à l'approvisionnement en eau potable et à la dilution des eaux usées, et ont engendré des pertes d'emploi temporaires dans les usines de pâtes et papiers. Les gens ont vraiment craint que la rivière Cowichan ne tarisse s'il ne pleuvait pas bientôt.

Pendant la période de 100 jours de temps presque parfait entre le 3 juillet et le 9 octobre, le soleil a brillé tous les jours, sauf trois. Cette période prolongée de temps clément a fait le bonheur des vinificateurs de la Colombie-Britannique qui prévoyaient un excellent cru avec des niveaux de sucre élevés. Dans le nord-est, à Fort St. John, à peine 1 mm de pluie est tombé en septembre, un chiffre bien inférieur au bas niveau record de 15,4 mm en 2006 et à la moyenne mensuelle de 45,7 mm pour septembre. Les rivières de la majeure partie de la région de la rivière de la Paix ont frôlé des bas niveaux historiques, aboutissant à un avertissement de basses eaux pour l'est de la région et à une suspension des extractions d'eau à court terme dans les rivières locales pour les exploitations pétrolières et gazières.

Le 13 octobre, la période sèche de 11 semaines à Vancouver s'est terminée. Et lorsqu'il a commencé à pleuvoir, il est tombé des cordes, annoncées par des vents forts avec des rafales de 158 km/h le long des côtes. En 27 jours, après le 11 octobre, 236 mm de pluie sont tombés à Vancouver avec seulement deux jours secs; pendant le même nombre de jours avant le 12 octobre, il y a eu deux jours humides avec une quantité totale de 2 mm de pluie.

Le Manitoba aux prises avec le feu et la glace!

Les habitants du sud-est du Manitoba n'avaient pas vraiment le goût de témoigner leur reconnaissance la semaine précédant l'Action de grâce, où ils ont dû affronter des phénomènes climatiques extrêmes, notamment des feux irréprimés, des bancs de neige abondants et une pluie verglaçante paralysante. Tout a commencé à Vita, Saint-Malo, où les résidants et les collectivités avoisinantes ont dû quitter les lieux lorsque des feux d'herbe et de brousse, provoqués par de violents vents chauds et secs, ont ravagé plusieurs établissements et même un pont. Certaines personnes ont décidé d'arroser les arbres et l'herbe sur leurs propriétés afin de prévenir la propagation des flammes. Malgré tous ces efforts, quatre familles ont perdu leur maison en raison des incendies. Deux jours plus tard, une tempête hivernale a frappé la région et a rapidement éteint les flammes. Néanmoins, la tempête a déversé d’abondantes chutes de neige mouillée (jusqu'à 30 cm), ce qui a entraîné la fermeture de routes et des pannes d'électricité dans une douzaine de collectivités. Les déplacements sur la Transcanadienne et d'autres routes ont été rigoureusement limités en raison de la visibilité réduite causée par la poudrerie provenant des vents du nord, qui atteignaient jusqu'à 70 km/h. Pour empirer encore les choses, une épaisse couche de glace de 8 cm s'est formée sur les lignes électriques et les arbres, ce qui provoqua l'effondrement de 165 poteaux électriques et d'un pylône. Puisque les équipes du service public ont eu du mal à se rendre jusqu’aux lignes électriques tombées pour les réparer, jusqu'à 6 000 personnes ont été privées d'électricité. Dans la région d’Interlake, des vents soufflant en rafales ont poussé l'eau du lac Winnipeg dans les rues de Gimli.

Chutes de neige record dans les Prairies

Deux puissants systèmes météorologiques venant du sud de la frontière se sont attardés au-dessus des Prairies pendant cinq jours avant le jour du Souvenir. Cet épisode hivernal précoce a mené la vie dure aux automobilistes et aux piétons depuis les contreforts des Rocheuses jusqu'au nord-ouest de l'Ontario. La première tempête s'est formée au dessus de l'Idaho et du Montana le 7 novembre et s'est déplacée vers le nord, jusqu'en Alberta. Au début, les précipitations sont tombées sous forme de pluie verglaçante à Edmonton, mais elles se sont vite transformées en neige abondante et humide (30 cm), faisant des ravages sur les routes et obligeant la fermeture des écoles. Calgary et le reste du sud de l'Alberta ont également reçu de 20 à 30 cm de neige. Deux jours plus tard, une tempête venant du Colorado et gonflée de l'humidité du golfe du Mexique est arrivée au dessus de la Saskatchewan et du Manitoba. De la neige tourbillonnante alimentée par de forts vents froids a rendu les conditions de conduite automobile dangereuses, causant des centaines de collisions dans tout le sud et dans des régions du centre des deux provinces. Les gens ont peiné à pelleter les 25 à 40 cm de neige tombés sous des vents soufflant en rafales à plus de 50 km/h.

Entre le 9 et le 11 novembre, il est tombé 34 cm de neige sur la ville de Regina. La majeure partie de cette neige, soit 24 cm, est tombée le 9 novembre, constituant un nouveau record journalier. Plus d'un mois avant le début officiel de l'hiver, les résidents de Regina étaient déjà fatigués de dégager ces quantités record de neige. Au cours des trois premières semaines du mois de novembre, il est tombé sur la ville plus de neige qu'au cours des six mois d'hiver de l'année dernière. Regina a connu le mois de novembre le plus enneigé depuis les premiers enregistrements dans les années 1880, avant même la fin du mois. Si les citadins en avaient plus qu'assez, les agriculteurs, eux, jubilaient, car la neige humide a aidé à compenser le bas niveau d'humidité causé par des semaines de faibles précipitations.

Le changement de mois n'a pas changé les conditions météorologiques. Au début de décembre, une autre tempête renfermant plus de pluie verglaçante et de neige a traversé les Prairies, ce qui a entraîné des conditions routières dangereuses le long de la Transcanadienne. Les conditions étaient également dangereuses entre Edmonton et Saskatoon. Le transport interprovincial a été interrompu pendant plusieurs heures. Cette violente tempête hivernale n'a recouvert de neige que certaines parties du centre du Manitoba, mais elle a tout de même fait des ravages, les accumulations allant des genoux à la ceinture ont formé des congères de deux mètres. Certains endroits ont reçu de 40 à 90 cm de neige, battant ainsi les records de chutes de neige en une journée. À peine quelques jours plus tard, soit le 5 décembre, Edmonton a reçu une autre bordée de 15 cm de neige, ce qui a réduit la visibilité et paralysé la circulation une fois de plus. Les habitants des Prairies commençaient à se lasser de l'hiver, mais la saison n'allait débuter que deux semaines plus tard.

Note du Rédacteur: Les finalistes de événements marquants sont des épisodes météorologiques qui ont été considérés, évalués puis classés mais qui n'ont pas atteint la liste des 10 événements les plus marquants de l'année.

Six Graduate Studentships in Regional Climate Modelling and Diagnostics - UQAM Montreal

The Centre ESCER at the Université du Québec à Montréal (UQAM), Canada, offers 12 MSc and 13 PhD scholarships for diverse research topics as part of a 5-year multi-institutional project titled "Canadian Network for Regional Climate and Weather Processes" let by Prof. Laxmi Sushama at UQAM. Students from any country are invited to apply.

Our university, a French-speaking institution located at the heart of bilingual Montréal, has successfully graduated many international students. The Centre ESCER has been particularly able to attract excellent students from Latin America, Eastern Europe and French-speaking countries, and provide them an education in French while having access to a fully bilingual working milieu.

We are seeking 6 Graduate Students interested in carrying research in the following topics:
1. Regional climate model added value in simulating significant weather events: This project may appeal to students with a good base in synoptic meteorology and wishing to explore the abilities of high-resolution climate models to well represent observed weather phenomena.
2. Objective optimisation of empirical model parameters: This project may appeal to students interested in understanding the complex role that model parameters play in the achievement of an optimal performance with a climate simulation.
3. Specific statistical tests for nested-model experiments: Applicants to this project will benefit from a strong background in inferential statistics and interest in adapting existing statistical tools within the context of regional modelling with nested models.

Enquiries about the proposed research projects should be submitted to Prof. René Laprise (laprise.rene@uqam.ca) and to Dr. Ramón de Elía (de_elia.ramon@ouranos.ca)

Information about the UQAM graduate programmes can be found at the following web sites:

Masters in Atmospheric Sciences: http://www.programmes.uqam.ca/3412
PhD in Earth and Atmospheric Sciences: http://www.programmes.uqam.ca/3141

To apply for Graduate Studies at UQAM, please complete the on-line application at http://www.regis.uqam.ca/candidat/superieur.html

Prospective foreign students should be aware that they require a study permit (student visa) to study in Canada and that delays are long to obtain the required immigration documents.

(1 March 2013)

REPORT / RAPPORT

CMOS Tour Speaker 2013
Ocean and climate change

Denis Gilbert[1]

The 2013 CMOS Speaker Tour was conducted from January 15 to February 8. In the first two weeks, I visited seven CMOS centres in a westward sequence from Toronto to Victoria. This was followed by a quieter third week during which I gave two talks in the Rimouski area and a third talk in Quebec City. The fourth and final week was the busiest of all with talks on consecutive days in Montreal, Ottawa, Fredericton, Halifax and St. John's.

Aspects of climate change that were touched upon during the talk included global decadal changes in surface air temperature, changes in energy content due to enhanced greenhouse gases in the various compartments of the Earth's climate system with oceans accounting for about 90% of the total, the oceans' thermohaline circulation, the hydrological cycle, ocean deoxygenation, ocean acidification, sea level rise and the apparent discrepancy between sea ice melting in the Arctic and sea ice growth around Antarctica. A PDF file of the talk can be downloaded from the CMOS website (http://www.cmos.ca/tourspkr.html).

At each CMOS centre, the contents of the talk were adjusted based on the dominant area of expertise of the local audience: meteorology (e.g. Toronto and Kelowna), oceanography (e.g. Halifax, Rimouski and St. John's) or hydrology (Saskatoon). A most pleasant part of this tour was that question period differed substantially from one venue to the next, based on the areas of expertise of those present. Precise head counts were only obtained in Kelowna (12) and Ottawa (52). In other venues, attendance was roughly estimated to within the closest multiple of 5 or 10. Total attendance at the 14 CMOS centres and 17 venues was thus estimated at 784 ± 50 persons. I am grateful to all CMOS Centre representatives for publicizing the talk in their local scientific community and for looking after the logistical arrangements for the talk, such as securing a room of appropriate size and making sure a projector was present in the room. I also thank André Giguère, CMOS Corresponding Secretary, for his efforts to find a schedule that best suited the local CMOS Centres and me.

Note: See detailed attendance report on next page.
Voir le rapport détaillé de l'assistance à la page suivante.

[1] Institut Maurice-Lamontagne, Pêches et Océans Canada, Mont-Joli, Québec, Canada

Conférencier itinérant SCMO 2013
Océans et changements climatiques

Denis Gilbert[1]

Le tour itinérant 2013 de la SCMO s'est déroulé du 15 janvier au 8 février. Au cours des deux premières semaines, j'ai visité sept centres SCMO en progressant vers l'ouest de Toronto à Victoria. Ceci fut suivi d'une troisième semaine plus tranquille au cours de laquelle j'ai donné deux conférences dans la région de Rimouski et une autre dans la ville de Québec. La quatrième et dernière semaine fut la plus occupée de toutes avec des conférences dans une ville différente chaque jour : Montréal, Ottawa, Fredericton, Halifax et St. John's.

Les thématiques liées aux changements climatiques qui furent abordées pendant la conférence comprenaient les changements globaux décennaux de la température de l'air de surface, les changements de contenu énergétique résultant de l'augmentation des gaz à effet de serre dans les différents compartiments du système climatique de la Terre, avec les océans comptant pour environ 90% du total, la circulation thermohaline océanique, le cycle hydrologique, la désoxygénation des océans, l'acidification des océans, l'élévation du niveau de la mer et la contradiction apparente entre la fonte des glaces de mer dans l'Arctique et la croissance des glaces de mer autour de l'Antarctique. Un fichier PDF de la conférence peut être téléchargé à partir du site web de la SCMO (http://www.cmos.ca/tourspkr.html).

À chaque centre SCMO, le contenu de la conférence fut ajusté en fonction du domaine de spécialité dominant parmi le public local: météorologie (par exemple, Toronto et Kelowna), l'océanographie (par exemple, Halifax, Rimouski et St-John's) ou l'hydrologie (Saskatoon). Un aspect particulièrement agréable de cette tournée fut la période des questions qui différait considérablement d'un endroit à l'autre, en fonction des domaines d'expertise des personnes présentes. Un dénombrement précis de l'assistance n'a été obtenu qu'à Kelowna (12) et Ottawa (52). Dans les autres lieux, la fréquentation a été estimée approximativement au plus proche multiple de 5 ou 10. La fréquentation totale dans les 14 centres CMOS et 17 lieux fut ainsi estimée à 784 ± 50 personnes. Je suis reconnaissant envers tous les représentants des centres SCMO pour avoir publicisé la conférence auprès de leur communauté scientifique locale et pour s'être occupés de l'organisation logistique de la conférence, tel que s'assurer de la disponibilité d'une salle de taille appropriée et voir à ce qu'un projecteur soit présent dans la salle. Je remercie également André Giguère, secrétaire de correspondance de la SCMO, pour ses efforts visant à trouver le meilleur horaire possible convenant à la fois aux centres locaux de la SCMO et à moi.

Dates and attendance at the 17 venues of the 2013 CMOS Speaker Tour / *Dates et assistance aux 17 endroits visités par le conférencier itinérant SCMO 2013*.

Date	Venue / Endroit	Attendance Assistance
2013-01-15	Toronto	40
2013-01-16	Winnipeg	35
2013-01-17	Saskatoon	20
2013-01-18	Edmonton	70
2013-01-21	Kelowna	12
2013-01-22	Vancouver (UBC)	40
2013-01-23	Victoria (U.Vic)	40
	Victoria (IOS)	50
2013-01-30	Rimouski (IML)	60
	Rimouski (ISMER)	50
2013-01-31	Québec (U. Laval)	50
2013-02-04	Montréal (CMC)	60
	Montréal (UQAM)	40
2013-02-05	Ottawa	52
2013-02-06	Fredericton	60
2013-02-07	Halifax	55
2013-02-08	St. John's	50

President Obama's 2013 State of the Union Address on Climate Change

"We, the people, still believe that our obligations as Americans are not just to ourselves, but to all posterity. We will respond to the threat of climate change, knowing that the failure to do so would betray our children and future generations. Some may still deny the overwhelming judgment of science, but none can avoid the devastating impact of raging fires, and crippling drought, and more powerful storms. The path towards sustainable energy sources will be long and sometimes difficult. But America cannot resist this transition; we must lead it. We cannot cede to other nations the technology that will power new jobs and new industries – we must claim its promise. That's how we will maintain our economic vitality and our national treasure – our forests and waterways; our croplands and snowcapped peaks. That is how we will preserve our planet, commanded to our care by God. That's what will lend meaning to the creed our fathers once declared".

Source: http://www.nytimes.com/interactive/2013/01/22/us/politics/22obama-inaugural-speech-annotated.html#/?annotation=194723b0b

DVD on Wind Energy in Canada
DVD sur l'Énergie du Vent au Canada

Wind farms are a good natural source of renewable, green energy for some people but an industrial encroachment into quiet rural areas for others. Both views are presented in this video but the main goal is to present some of the background to wind energy in Canada, and, in Part B, some details of the physics of wind energy and wind turbines.

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Les parcs éoliens sont une bonne source naturelle d'énergie renouvenable et verte à certaines personnes mais un empiétement industriel en zones tranquilles et rurales pour d'autres. Les deux opinions sont présentées dans le vidéo, mais l'objectif principal est de présenter quelques informations de base sur l'énergie éolienne au Canada, et, dans la partie B, certains détails de la physique de l'énergie éolienne et les éoliennes.

Producer: Peter Taylor (pat@yorku.ca)
Director & Editor: Lizz Hodgson
Location Sound: Simone Rapisarda Casanova
Cinematographer: Rozette Ghadery
Post Sound Design: Shawn Jurek

Copies are available free of charge while they last!

2013 Joint Scientific Congress

Canadian Meteorological and Oceanographic Society (CMOS),

Canadian Geophysical Union (CGU) and the

Canadian Water Resources Association (CWRA)

May 26 to May 30, 2013

at the TCU Place Saskatoon, Saskatchewan

The 1st Joint Scientific Congress of the CMOS, CGU and CWRA will take place from May 26th to 30th 2013 at Teacher's Credit Union Place in Saskatoon, Saskatchewan. The venue, TCU Place, is located in the heart of downtown Saskatoon within walking distance of several Saskatoon hotels and the beautiful South Saskatchewan River valley. The 2013 Congress theme is "***Bridging Environmental Science, Policy and Resource Management***". The Local Arrangements Committee and the Scientific Program Committee are working hard on the preparations for the 2013 Congress and are looking forward to welcoming you!

Important Dates to Remember in 2013

- April 12th, 2013: Early-Bird Congress registration deadline;
- April 25th, 2013: Hotel accommodations rate guarantee deadline;
- May 25th, 2013: Late Congress registration deadline;
- May 26th, 2013: Start of Congress, business meetings, and workshops;
- May 27th, 2013: Opening ceremony and start of science sessions
- May 28th, 2013: Public Lecture (7pm), Awards Luncheons (12pm);
- May 29th, 2013: Annual Banquets (6:30 pm).

2013 Congress Workshops

Several workshops are being offered in conjunction with this Joint Scientific Congress.

Please register for these workshops when registering for the Congress by using the online registration system: https://www1.cmos.ca/meetings/meetings_register.asp. Registration for workshops is at no extra cost. However, note that registration and participation in these workshops requires Congress registration for at least one day.

Saskatoon is known as the "*Paris of the Prairies*" for its numerous bridges crossing the South-Saskatchewan River

Arrangements for food or beverage during these workshops (scheduled for Sunday May 26th or Friday May 31st) are being left to the discretion of the organizers and are not included in Congress registration.

The list of workshops follows. Some workshops will be soliciting abstracts, presenters, and other content. Please contact the organizer listed below for further details or to inquire about abstract submission. Workshop abstract submissions are not subject to the Congress abstract deadline (contact organizer for more details).

<u>All Day Sunday (May 26th) Workshops</u>

1) Hands-on Workshop on Geophysical High Pressure Research in Conjunction with Synchrotron Radiation
- Organizer: Hans Mueller
- Contact Info: hjmuel@qfz-potsdam.de

2) R Workshop
- Organizer: David Hutchison
- Contact Info: david.hutchison@ec.gc.ca

3) Marketing Communications of Sciences – Telling Your Science Story Strategically
- Organizer: Vera Reifenstein
- Contact Info: vera.reifenstein@maritimeway.ca

4) A Workshop Regarding the Use of Commercial Finite Element Modelling Packages in Solid Earth Geophysics
- Organizer: Sam Butler
- Contact Info: sam.butler@usask.ca

5) 15th Canadian Geoid Workshop
- Organizer: Marc Veronneau
- Contact Info: marc.veronneau@NRCan-RNCan.gc.ca

6) Climate and Water Availability Indicators for Canada. Challenges and a Way Forward
• Organizer: Grace Koshida
• Contact Info: grace.koshida@ec.gc.ca

7) Climate Change and Atmospheric Research Initiative
• Organizer: Dave Bowen
• Contact Info: dave.bowen@nserc-crsng.gc.ca

Monday Afternoon (May 27th) Workshop

1) Addressing Lake Winnipeg Eutrophication
• Organizer: Jim Bruce
• Contact Info: jpbruce@sympatico.ca

All Day Friday (May 31st) Workshop

New approaches for the creation of IDF Curves
• Organizer: Philip Jarrett
• Contact Info: philip.jarrett@usask.ca

Plenary Speakers at Congress

• Howard Wheater, Global Institue for Water Security at University of Saskatchewan "*Global to Regional Water Security Issues*".

• Ted Shepherd, Department of Meteorology, University of Reading, UK, "*MOPE - Understanding Uncertainty in Climate Models: Robustness of the Atmospheric Circulation Response to Climate Change*".

• W. Richard Peltier, Department of Physics, University of Toronto, "*The Thermohaline Circulation of the Oceans: Impacts on Climate Variability and Change*".

• Robie MacDonald, Institute of Ocean Sciences, Department of Fisheries and Oceans, *"Freshwater inflows to Arctic Ocean, the carbon cycle and impacts of aquatic ecosystems*".

• Garry Rogers, Geological Survey of Canada "*Earthquake and tsunami hazards on Canada's west coast"*.

• Don White, Geological Survey of Canada *"The Geological CO_2 sequestration in Aquistore Project"*.

• Paul Myers, Earth & Atmospheric Science, University of Alberta, Edmonton "*Arctic oceanography theme*".

• John Pomeroy, Centre for Hydrology, University of Saskatchewan "*Water Resources and climate change*".

Sponsorship at time of publication

- Platinum: Campbell Scientific;
- Gold: Fisheries and Oceans Canada and The Weather Network;
- Silver: University of Saskatchewan, Water Security, Agriculture and Agri-food Canada, City of Saskatoon and Environment Canada;
- Other: Hoskin Scientific and Taylor & Francis.

Special thanks to Pacific Institute for the Mathematical Sciences for supporting the *Mathematics of Planet Earth* Sessions

For more information, please contact the Joint Scientific Program Committee Co-Chair (geoff.strong@shaw.ca) or the Chair Local Arrangements Committee (craig.smith@ec..gc.ca) or check the congress website at:

http://www.cmos.ca/congress2013

Congrès scientifique conjoint 2013

Société canadienne de météorologie et d'océanographie (SCMO),

Union géophysique canadienne (UGC)

Association canadienne des ressources hydriques (ACRH)

du 26 mai au 30 mai, 2013

au TCU Place
Saskatoon, Saskatchewan

Le premier congrès scientifique conjoint de la SCMO, de l'UGC et de l'ACRH aura lieu du 26 au 30 mai, 2013, au Teacher's Credit Union Place à Saskatoon, en Saskatchewan. Le centre, TCU Place, est situé en plein centre ville de Saskatoon, à distance de marche de plusieurs hôtels et de la pittoresque rivière Saskatchewan. Le thème choisi pour le congrès de 2013 est ***Intégration des sciences de l'environnement, de la politique et de la gestion des ressources***. Les comités pour les préparatifs locaux et pour le program scientifique s'occupent activement des détails de l'organisation du Congrès 2013 afin de mieux vous accueillir!

Saskatoon est reconnu comme étant le "*Paris des Prairies*" à cause de ses nombreux ponts qui traversent la rivière South-Saskatchewan

Dates importantes à retenir en 2013:

• Date limite pour l'inscription anticipée: 12 avril 2013;
• Date limite pour les réservations d'hôtel à tarif garanti: 25 avril 2013;
• Date limite pour l'inscription au congrès: 25 mai 2013;
• Début du congrès, réunions d'affaires et ateliers: 26 mai 2013;
• Cérémonie d'ouverture et début des sessions scientifiques : 27 mai 2013;
• Conférence publique (19:00 heures), déjeuners bourses (12:00 heures) : 28 mai 2013;
• Banquets annuels (18:30 heures) : 29 mai 2013.

Ateliers du congrès de 2013

Plusieurs ateliers seront offerts pendant ce congrès scientifique conjoint.

S'il vous plaît vous inscrire à ces ateliers lors de l'inscription au Congrès en utilisant le système d'inscription en ligne: https://www1.cmos.ca/french/meetings/meetings_register.asp. Il n'y a aucun coût supplémentaire pour s'inscrire aux ateliers. Il est toutefois important de noter que l'inscription et la participation à ces ateliers nécessitent l'inscription au congrès pour au moins une journée. La fourniture de nourriture et de boissons pendant ces ateliers (prévus le dimanche 26 mai et le vendredi 31 mai) est laissée à la discrétion des organisateurs et n'est pas comprise dans l'inscription au congrès.

La liste des ateliers suit. Cliquez sur le nom de l'atelier ci-dessous afin de voir la description. Les organisateurs de certains ateliers demandent encore des résumés, des conférenciers et d'autres contenus. Veuillez communiquer avec ceux-ci pour obtenir de plus amples renseignements ou poser des questions relatives à la soumission de résumés. La soumission de résumés pour les ateliers n'est pas visée par la date limite de présentation d'un résumé pour le congrès (communiquez avec l'organisateur pour obtenir de plus amples renseignements).

Ateliers d'une journée - dimanche, le 26 mai

1) Hands-on Workshop on Geophysical High Pressure Research in Conjunction with Synchrotron Radiation
• Organisateur: Hans Mueller
• Coordonnées: hjmuel@gfz-potsdam.de

2) R Workshop
• Organisateur: David Hutchison
• Coordonnées: david.hutchison@ec.gc.ca

3) Marketing Communications of Sciences – Telling Your Science Story Strategically
• Organisateur: Vera Reifenstein
• Coordonnées: vera.reifenstein@maritimeway.ca

4) A Workshop Regarding the Use of Commercial Finite Element Modelling Packages in Solid Earth Geophysics
• Organisateur: Sam Butler
• Coordonnées: sam.butler@usask.ca

5) 15th Canadian Geoid Workshop
• Organisateur: Marc Veronneau
• Coordonnoées: marc.veronneau@NRCan-RNCan.gc.ca

6) Climate and Water Availability Indicators for Canada. Challenges and a Way Forward
• Organisateur: Grace Koshida
• Coordonnées: grace.koshida@ec.gc.ca

7) Climate Change and Atmospheric Research Initiative
• Organisateur: Dave Bowen
• Coordonnées: dave.bowen@nserc-crsng.gc.ca

Ateliers du lundi après-midi, le 27 mai

1) Addressing Lake Winnipeg Eutrophication
• Organisateur: Jim Bruce
• Coordonnées: jpbruce@sympatico.ca

Atelier d'une journée - vendredi, le 31 mai

New approaches for the creation of IDF Curves
• Organisateur: Philip Jarrett
• Coordonnées: philip.jarrett@usask.ca

Conférenciers invités au Congress

• Howard Wheater, Global Institue for Water Security de l'Université de la Saskatchewan "*Global to Regional Water Security Issues*".

• Ted Shepherd, Departement de météorologie, Université de Reading, UK, "*MOPE - Understanding Uncertainty in Climate Models: Robustness of the Atmospheric Circulation Response to Climate Change*".

• W. Richard Peltier, Professeur de physique, Université de Toronto, "*The Thermohaline Circulation of the Oceans: Impacts on Climate Variability and Change*".

• Robie MacDonald, Institut des Sciences de la mer du Ministère des Pêches et Océans, *"Freshwater inflows to Arctic Ocean, the carbon cycle and impacts of aquatic ecosystems*".

• Garry Rogers, Commission géologique du Canada "*Earthquake and tsunami hazards on Canada's west coast"*.

• Don White, Commission géologique du Canada *"The Geological CO_2 sequestration in Aquistore Project"*.

• Paul Myers, Sciences de la terre et de l'atmosphère, Université de l'Alberta, Edmonton "*Arctic oceanography theme*".

• John Pomeroy, Centre for Hydrology, Université de la Saskatchewan "*Water Resources and climate change*".

Commanditaires au moment d'aller sous presse

- Platine Campbell Scientific;
- Or: Pêches et Océans Canada et Météo-Média;
- Argent: Université de la Saskatchewan, Water Security, Agriculture et agroalimentaire Canada, Cité de Saskatoon et Environnement Canada;
- Autre: Hoskin Scientific et Taylor & Francis.

Le comité organisateur remercie le "Pacific Institute for the Mathematical Sciences" pour son support des sessions de "*Mαthématiques de la planère terre*".

Pour plus de renseignements, communiquez avec le Comité conjoint du programme scientifique (Courriel: geoff.strong@shaw.ca) ou le Comité organisateur (craig.smith@ec..gc.ca) ou consultez le site web du congrès à:

http://www.cmos.ca/congress2013

Atmosphere-Ocean 51-1 Paper Order

Applied Research / Recherche appliquée

AO-2011-0075
Sea-Ice Motion and Flux within the Prince Gustaf Adolf Sea, Queen Elizabeth Islands, Canada during 2010
Trudy Wohlleben, Stephen E.L. Howell, Tom Agnew and Alexander Komarov

AO-2012-0026
A New Environment Canada Regional Ice Analysis System
Mark Buehner, Alain Caya, Lynn Pogson, Tom Carrières and Paul Pestieau

AO-2011-0070
Northwest Atlantic Surface Circulation from Multi-Satellite Observations
Kyoko Ohashi, Guoqi Han, Nancy Chen and Jim Helbig

AO-2012-0045
A High-Resolution Canadian Lightning Climatology
Mark W. Shephard, Robert Morris, William R. Burrows and Leslie Welsh

Fundamental Research / Recherche fondamentale

AO-2011-0072
Contrasting the Flow Patterns in The Equatorial Pacific Between Two Types of El Niño
Li-Chiao Wang and Chau-Ron Wu

AO-2012-0033
Comparisons of the Thermal Effects of the Tibetan Plateau with NCEP-I and ERA-40 Reanalysis Data
Shanshan Zhong, Zhiwei Wu and Jinhai He

AO-2011-0087
Declining Oxygen on the British Columbia Continental Shelf
William R. Crawford and M. Angelica Peña

AO-2012-0022
Global Climate Model (CanAM4). Part I: Representation of Physical Processes
Knut von Salzen, John F. Scinocca, Norman A. McFarlane, Jiangnan Li, Jason N. S. Cole, David Plummer, Diana Verseghy, M. Cathy Reader, Xiaoyan Ma, Michael Lazare and Larry Solheim

AO-2012-0047
Evidence of Change in the Winter Mixed Layer in the Northeast Pacific Ocean: A Problem Revisited
Howard J. Freeland

Atmosphere-Ocean 51-2 Paper Order

Applied Research / Recherche appliquée

AO-2012-0042
Integral Profile Estimates of Sensible Heat Flux from an Unconsolidated Sea-Ice Surface
R. L. Raddatz, R. J. Galley, L. M. Candlish, M. G. Asplin and D. G. Barber

AO-2012-0054
All-Sky Downwelling Longwave Radiation and Atmospheric-Column Water Vapour and Temperature over the Western Maritime Arctic
R. L. Raddatz, M. G. Asplin, T. Papakyriakou, L. M. Candlish, R. J. Galley, B. Else and D. G. Barber

AO-2012-0023
A Retrospective Analysis of Ozone Formation in the Lower Fraser Valley, British Columbia, Canada. Part I: Dynamical Model Evaluation
D. G. Steyn, B. Ainslie, C. Reuten and P. L. Jackson

AO-2012-0024
A Retrospective Analysis of Ozone Formation in the Lower Fraser Valley, British Columbia, Canada. Part II: Influence of Emissions Reductions on Ozone Formation
B. Ainslie, D. G. Steyn, C. Reuten and P. L. Jackson

Fundamental Research / Recherche fondamentale

AO-2011-0056
Investigation of the Natural Carbon Cycle since 6000 BC using an Intermediate Complexity Model: The Role of Southern Ocean Ventilation and Marine Ice Shelves
Christopher T. Simmons, Lawrence A. Mysak and H. Damon Matthews

AO-2012-0020
Improving Statistical Downscaling of General Circulation Models
Matthew Lee Titus, Jinyu Sheng, Richard J. Greatbatch and Ian Folkins

AO-2012-0040
Surface Rainfall and Cloud-to-Ground Lightning Relationships in Canada
B. Kochtubajda, W.R. Burrows, A. Liu and J.K. Patten

CMOS 2013 Photo Contest

All members with a photographic bent are invited to participate in the 2013 Photo Contest. Please submit your own original image files, either in colour or black and white, from scans of prints or digital capture of a meteorological or oceanographic subject, event, or phenomenon. Details on the photo contest can be found on the CMOS Web Page at:

http://www.cmos.ca/photocontest.html

Concours photographique 2013 de la SCMO

Tous les membres qui ont une passion pour la photographie sont invités à participer au concours de photographie 2013 de la SCMO. Prière de soumettre vos photos numériques originales, soit en couleur, soit en noir et blanc, à partir de copie papier ou de fichier numérique portant sur des sujets ou phénomènes météorologiques ou océanographiques. Les détails du concours se trouvent sur le site web de la SCMO à l'adresse:

http://www.cmos.ca/photocontest.html

Mark your calendar
À inscrire à votre agenda

Earth Day: **22 April 2013**

Jour de la terre: **22 avril 2013**

World Ocean Day: **8 June 2013**

Journée mondiale des océans: **8 juin 2013**

BRIEF NEWS / NOUVELLES BRÈVES

Atmospheric physicist named inaugural director of University of Toronto's new School of the Environment

Wednesday, January 16, 2013 (Toronto) — Kimberly Strong, a physicist who leads investigations of the Earth's atmosphere, will soon lead the University of Toronto's new School of the Environment. Her term begins on July 1, 2013.

Strong's research in atmospheric measurements examines such key environmental issues as climate change and its relationship to contributing factors including stratospheric ozone depletion and tropospheric pollution. She has directed ground-based, balloon-borne and satellite projects to study the Earth's atmosphere, particularly in the Arctic.

"*We are thrilled to have Kim Strong serve as director of the School of the Environment*," said Meric S. Gertler, dean of the Faculty of Arts & Science. "*Kim has an extraordinary record as a researcher and has an enviable track record in encouraging and supporting the next generation of environmental scholars and scientists. Under her leadership, the school will be known for interdisciplinary research and teaching in environment that spans the sciences, social sciences and humanities*."

Strong is one of the founding members of the Canadian Network for the Detection of Atmospheric Change, a group of researchers working to improve atmospheric remote sounding in Canada. In 2004, the group obtained funding from the Canada Foundation for Innovation to equip the Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka, Nunavut to provide a long-term data set for studying the evolution of the Arctic atmosphere and its year-to-year variability. From 1998 to 2006, Strong was principal investigator of the Middle Atmosphere Nitrogen TRend Assessment (MANTRA) project, a large collaboration that used high-altitude instrument-carrying balloons to measure trace gases and investigate the changing chemical balance in the mid-latitude stratosphere. Strong is currently director of the Natural Sciences and Engineering Research Council's Collaborative Research and Training Experience (CREATE) Training Program in Arctic Atmospheric Science. The program enhances the educational opportunities available to students and postdoctoral fellows interested in polar, atmospheric, and climate sciences, including the use of state-of-the-art instrumentation and analysis of large data sets. She also runs U of T's Atmospheric Observatory (TAO), is principal investigator of the new Canadian Fourier Transform InfraRed Observing Network (CAFTON), and is actively involved in several projects related to better understanding of the atmospheres of Mars and Venus.

Strong and members of her group are actively involved in outreach activities, through an education and outreach program developed by U of T physicist Kaley Walker. This began with a visit to Qarmartalik School in Resolute Bay, Nunavut in 2004, and has since expanded to schools in Hall Beach, Igloolik, Grise Fiord, Iqaluit, and Pond Inlet, as well as many public talks and visits to schools in Southern Canada. Activities ranging from the ambitious "Northern Experience Program" undertaken as part of International Polar Year, to the current "Student-Researchers Atmospheric Collaboration" have brought schools, students, and researchers together in creative ways to enhance their learning experience, excite them about science, and raise awareness of Arctic issues. Walker and Strong, with the help of two outreach facilitators, graduate students, and post-docs, have developed presentations and hands-on activities appropriate for grades Kindergarten to 12, on topics such as air pollution, ozone depletion, climate, Canadian satellites, space science, and weather. These activities have led to invitations to present hands-on workshops at schools and at teachers' conferences in Nunavut and Ontario.

Strong joined U of T's Department of Physics as an assistant professor in 1996 and became associate professor in 2001, and professor in 2006. She is also a member of U of T's Centre for Global Change Science. In 2010, Strong was a visiting fellow at the Centre for Atmospheric Chemistry, University of Wollongong, Australia. Her awards include the Premier's Research Excellence Award (2004) and an NSERC Discovery Accelerator Supplement award for three years (2011).

The School of the Environment was established in July 2012 to leverage the enormous breadth and depth of environmental teaching and research expertise within the Faculty of Arts & Science. The school offers an undergraduate B.A. program in environmental studies and a B.Sc. program in environment and science, with other new programs in development. The school also partners with other departments and programs at U of T to offer a range of collaborative undergraduate specialists, majors and minors, involving chemistry, geography, earth sciences, human biology, physics, philosophy and others. At the graduate level, interdisciplinary collaborative programs in Environmental Studies, as well as in Environment and Health, are offered in partnership with 20 other units at the university. In addition, distance education and certificate programs provide opportunities for professional development.

"*I envision the school as a dynamic unit that serves as a nexus for faculty, bringing together scholars from a wide range of disciplines, strengthening existing links, and creating new ways of collaborating and interacting with colleagues*," said Strong. "*It will also serve as a magnet for* *students interested in the environment, offering them the best courses and programs in this field available anywhere. Thirdly, the school will be a portal for the wider community beyond the university, providing access to all of the diverse and interdisciplinary environmental scholarship that is underway here. My job is to make all three happen*!"

Source: Faculty of Arts and Science

Canada's Experimental Lakes Area Highlighted at International Meeting on Aquatic Sciences

Wednesday, February 20, 2013 (Winnipeg) — On the first day of the annual meeting of the Association for the Sciences of Limnology and Oceanography this week in New Orleans, the current president, the president-elect, and the two prominent aquatic scientists giving opening addresses were not dressed in the usual attire.

No, they weren't dressed for Mardi Gras. They were all wearing T-shirts that say "***Save Our ELA***".

SAVE ELA
EXPERIMENTAL LAKES AREA

This was the first ASLO meeting since the government of Canada announced the closure of the Experimental Lakes Area (ELA), scheduled for March 31.

"*As we kick off this exciting 2013 ASLO meeting here in New Orleans, it is sobering for me to think that the core contributions from ELA that have been stalwart components of five decades of ASLO meetings will someday be no more*", said Dr. James Elser, ASLO President-elect. "*The theme of the meeting is 'Learning For The Future'. How can we learn and thus assure the future of lakes without the ELA?*"

Two former ELA scientists, Dr. Karen Kidd and Dr. David Schindler, were the featured speakers. Dr. Kidd headed the only whole lake experiment on endocrine disrupters that has ever been done. She is now Canada Research Chair in Chemical Contamination of Food Webs at the University of New Brunswick, and is co-editor of a big UNEP/WHO report on endocrine disruptors

http://www.unep.org/hazardoussubstances/Portals/9/EDC/StateOfEDCScience.pdf

that is being released today.

"*Dr. Kidd's cutting-edge experiment with endocrine disruptors in whole lakes at ELA indicates that we have a huge problem on our hands with such chemicals*", said Dr. David Schindler, Killam Memorial Chair and Professor of Ecology in the Department of Biological Sciences at the University of Alberta in Edmonton, Canada. "*Fish populations are clearly at risk in rivers in heavily populated areas because of inputs of municipal wastewater discharges. That is why it is of interest to this international society of water experts*."

Photo Caption: Dr. John Downing, ASLO President and Iowa State University, Dr. Azit Mazumder, University of Victoria, Dr. Karen Kidd, University of New Brunswick, Dr. James Elser , ASLO President-elect and Arizona State University and Dr. David Schindler, Killam Memorial Professor, University of Alberta.

But even more than highlighting a specific environmental problem, there was concern over the lack of action by Canada's Department of Fisheries and Oceans (DFO) in continuing the ELA and the unique type of research that is carried out there.

"*It seemed like every talk in the plenary today used pieces of science derived from or inspired by ELA science,*" said Dr. John Downing, current ASLO President. "*The closure of ELA at a time when pressure on good water is increasing exponentially is a tragedy for the public good and the scientific enterprise.*"

While DFO has been saying for months that it hopes to see the ELA transferred successfully to a new operator who will ensure that the whole ecosystem approach will continue to be used, there is still no new operator in place.

"*While we still hope that the government will reverse its decision, at the very least we hope that the time line will be extended for long enough that the complex job of transferring the ELA to a new operator can be successfully accomplished,*" said Dr. Britt Hall, University of Regina professor and head of the Coalition to Save ELA. "*We hope that as many attendees as possible will buy our T-shirts and* *wear them. Even better, send one to your congressman or MP!*"

Marine Geodesy Publishes New Application Studies of OSTM/Jason-2 Program

The Ocean Surface Topography Mission (OSTM)/Jason-2 is an international program that continues the precise altimetry data record of ocean circulation and global sea level change into the next decade. The mission represents the successful transition from the TOPEX/Poseidon and Jason-1 research missions to a fully operational altimetry mission. OSTM has brought together a four-partner group of agencies: NASA and CNES research agencies, plus the EUMETSAT and NOAA operational agencies.

The calibration/validation aspects of OSTM/Jason-2 were described in two previous issues of Marine Geodesy. This third supplement issue "OSTM/Jason-2 Applications — Part 3" expands on the previous issues with a variety of new application studies such as interannual ocean variability, surface currents, tide modeling, and climate studies. Professor George Born of the University of Colorado, Boulder, and Professor Subrahmanyam Bulusu of the University of South Carolina served as guest editors of the supplement issue. For free online access to the supplement issue, visit:

http://www.tandfonline.com/toc/umgd20/35/sup1

The contributions of Jason-2 to the altimetry constellation have become more important than ever, as the Jason-3 and Jason CS (Jason Continuity of Service) missions are being developed to ensure the crucial continuity of observational services for operational applications as well as climate assessment.

Public Acceptance of Climate Change Affected by Word Usage

Better science communication could lead to a more informed public.

Public acceptance of climate change's reality may have been influenced by the rate at which words moved from scientific journals into the mainstream, according to anthropologist Michael O'Brien, dean of the College of Arts and Science at the University of Missouri. A recent study of word usage in popular literature by O'Brien and his colleagues documented how the usage of certain words related to climate change has risen and fallen over the past two centuries. Understanding how word usage affects public acceptance of science could lead to better science communication and a more informed public.

"*Scientists can learn from this study that the general public shouldn't be expected to understand technical terms or be convinced by journal papers written in technical jargon*," O'Brien said. "*Journalists must explain scientific terms in ways people can understand and thereby ease the movement of those terms into general speech. That can be a slow process. Several words related to climate change diffused into the popular vocabulary over a 30-50 year timeline.*"

O'Brien's study found that, by 2008, several important terms in the discussion of climate change had entered popular literature from technical obscurity in the early 1900s. These terms included:

- **Biodiversity** – the degree of variation in life forms within a given area;
- **Holocene** – the current era of the Earth's history, which started at the end of the last ice age;
- **Paleoclimate** –the prehistoric climate, often deduced from ice cores, tree rings and pollen trapped in sediments;
- **Phenology** – the study of how climate and other environmental factors influence the timing of events in organisms' life cycles.

Not every term was adopted at the same rate or achieved the same degree of popularity. Biodiversity, for example, came into popular use quickly in only a few years in the late 80s and early 90s. Other terms, like Holocene or phenology, have taken decades and are still relatively uncommon.

"*The adoption of words into the popular vocabulary is like the evolution of species*," O'Brien said. "*A complex process governs why certain terms are successful and adopted into everyday speech, while others fail. For example, the term 'meme' has entered the vernacular, as opposed to the term 'culturgen,' although both refer to a discrete unit of culture,* *such as a saying transferred from person to person*."

To observe the movement of words into popular literature, O'Brien and his colleagues searched the database of 7 million books created by Google. They used the "*Ngram*" feature of the database to track the number of appearances of climate change keywords in literature since 1800. The usage rate of those climate change terms was compared to the usage of *"the*," which is the most common word in the English language. Statistical analysis of usage rates was calculated in part by co-author William Brock, a new member of MU's Department of Economics and member of the National Academy of Sciences.

The study, "*Word Diffusion and Climate Science*" was published in the journal PLOS ONE and can be viewed at:

http://www.plosone.org/article/info:doi/10.1371/journal.pone.0047966

.
Co-authors also included Phillip Garnett of Durham University.

Story Contact: Timothy Wall, walltj@missouri.edu

COMET Program

1) GOES-R ABI: Next Generation Satellite Imaging Module

The COMET Program is pleased to announce the publication of the new module "GOES-R ABI: Next Generation Satellite Imaging". This one-hour module focuses on the next generation GOES-R ABI 16-channel imager to be launched this decade. With increased spectral coverage, higher spatial resolution, more frequent imaging, and improved image pixel geolocation and radiometric performance, the ABI will bring significant improvements to forecasting, numerical weather prediction, and climate and environmental monitoring. The first part of the module introduces the ABI's key features and improvements over earlier GOES imagers. The second section lets users interactively explore the ABI's 16 channels. The third section contains movies that show the improvements that the ABI will bring to the following application areas: convection, flooding, wildfires, land cover, hurricanes, climate, air quality, aviation, coastal and marine, and fog and low visibility. The final section contains additional resources pertaining to the ABI. The module has numerous takeaways, including ten application movies and an interactive spectrum.

Please follow this link to the MetEd description page that provides additional information and a link to begin the module: GOES-R ABI: Next Generation Satellite Imaging. (https://www.meted.ucar.edu/training_module.php?id=987) This module uses JavaScript so please ensure that your browser is updated to the latest version, with JavaScript enabled. For technical support for the module, please visit our Registration and Support FAQs at https://www.meted.ucar.edu/resources_faq.php

Comments or questions regarding the content, instructional approach, or use of this module are welcome. Please e-mail your comments or questions to Patrick Dills (dills@ucar.edu).

2) Pressure Gradient Force Module

The COMET Program is pleased to announce the publication of a new learning object on Pressure Gradient Force, the first of a series of short, self-contained learning objects covering foundational concepts in dynamic meteorology. As a learning object, it is meant to be used to supplement other teaching material in a meteorology course by elucidating a specific concept. This particular learning object presents an interactive view of an idealized surface map allowing the student to adjust pressures on either side of the map and examine accelerations produced in response. The focus is on the horizontal pressure gradient force. Three brief examples with questions are also provided to reinforce key concepts.

Please follow this link to the MetEd description page that provides additional information and a link to begin: Topics in Dynamic Meteorology: Pressure Gradient Force (https://www.meted.ucar.edu/training_module.php?id=1024)

This publication is part of what will become a set of learning objects collected under the broader classification of "Topics in Dynamic Meteorology."

Most COMET products use JavaScript and Adobe® Flash® for navigation, animation, and/or presentation of multimedia elements. Ensure that you have a browser updated to its latest version with JavaScript enabled and the latest version of the Adobe FlashPlayer installed (http://get.adobe.com/flashplayer/). For technical support for this module please visit our Registration and Support FAQs at https://www.meted.ucar.edu/resources_faq.php.

Users' comments or questions regarding the content, instructional approach, or use of this learning object, are welcome. Please e-mail your comments or questions to Dave Linder (linder@comet.ucar.edu) or Greg Byrd (byrd@comet.ucar.edu).

2013 International Year of Water Cooperation

In December 2010, the United Nations General Assembly declared 2013 as the United Nations International Year of Water Cooperation (Resolution A/RES/65/154). In reflection of this declaration, the 2013 World Water Day, which will take place on 22 March 2013, also will be dedicated to water cooperation. Therefore, UN-Water has called upon UNESCO to lead the 2013 United Nations International Year on Water Cooperation, in particular because of the Organization's unique multidisciplinary approach which blends the natural and social sciences, education, culture and communication. Given the intrinsic nature of water as a transversal and universal element, the United Nations International Year of Water Cooperation naturally would embrace and touch upon all these aspects.

The objective of this International Year is to raise awareness, both of the potential for increased cooperation, and of the challenges facing water management in light of the increase in demand for water access, allocation and services. The Year will highlight the history of successful water cooperation initiatives, as well as identify burning issues on water education, water diplomacy, transboundary water management, financing cooperation, national/international legal frameworks, and the linkages with the Millennium Development Goals. It also will provide an opportunity to capitalize on the momentum created at the United Nations Conference on Sustainable Development (Rio+20), and to support the formulation of new objectives that will contribute towards developing water resources that are truly sustainable.

Celebrations throughout the Year will include featured events at UNESCO Headquarters in Paris, as well as many other events organized by various stakeholders around the world. Such events will seek to promote actions at all levels in relevant areas including education, culture, gender, the sciences, conflict prevention and resolution, as well as ethics, among others.

2013 Année internationale de la coopération dans le domaine de l'eau

*L'Assemblée générale des Nations Unies a proclamé 2013 "**Année internationale de la coopération dans le domaine de l'eau"*** (Résolution A/RES/65/154).

L'UNESCO a été officiellement nommé par l'ONU-Eau pour mener les préparatifs de cette Année, en raison notamment de l'approche multidisciplinaire pratiquée par l'Organisation, qui mêle les sciences naturelles et sociales, l'éducation, la culture et la communication.

L'objectif de l'Année internationale est de sensibiliser à la fois aux possibilités de développement de la coopération et aux défis que représente la gestion de l'eau, face à un accroissement de la demande d'accès, de répartition des ressources et de services d'approvisionnement. L'Année mettra en avant l'histoire des réussites qui ont marqué la coopération dans le domaine de l'eau. Tout au long de 2013, des célébrations et manifestations seront organisées au siège de l'UNESCO à Paris, ainsi qu'à travers le monde.

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Bridging Environmental Science, Policy and Resource Management

2013 Joint Scientific Congress of the CMOS, CGU and CWRA

Intégration des sciences de l'environnement, de la politique et de la gestion des ressources

2013 Congrès scientifique conjoint de la SCMO, de l'UGC et de l'ACRH

CWRA ACRH
Canadian Water Resources Association
Association Canadienne des Ressources Hydriques

CMOS SCMO
Canadian Meteorological and Oceanographic Society
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