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# Environmental Prediction in Canadian Cities

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## Environmental Prediction in Canadian Cities



Canadian Foundation for Climate  
and Atmospheric Sciences (CFCAS)

Fondation canadienne pour les sciences  
du climat et de l'atmosphère (FCSCA)



McGill

KING'S  
*College*  
LONDON



Environnement  
Canada

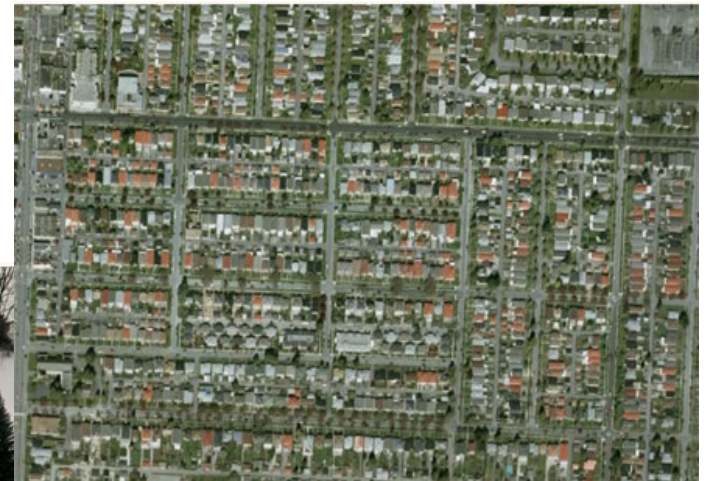
Environment  
Canada

# What is EPiCC?

- EPiCC is a research network: includes observations, remote sensing and numerical modeling components
  - Two cities: Montreal & Vancouver, 6 main observation sites, a focus on residential vegetated areas
  - Mandate: to complete research objectives (not necessarily HQP or outreach centred )



Montréal

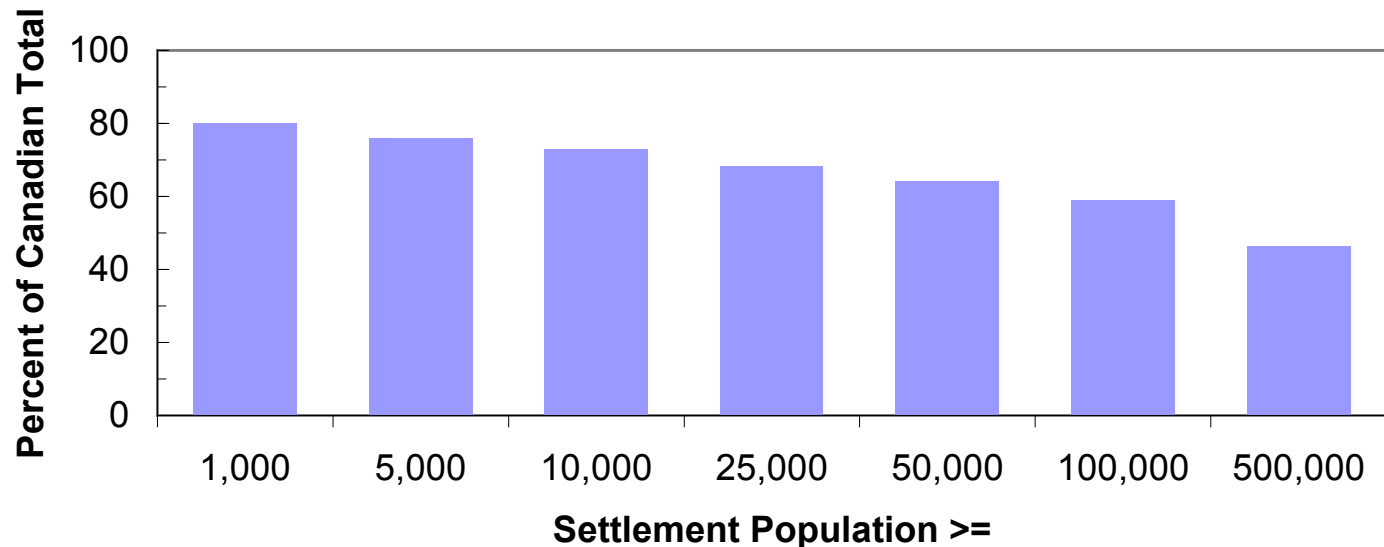


Vancouver



# What is the overall objective of EPiCC?

- To provide Canadian urban residents with better weather and air quality forecasts through development of an urban-atmosphere modeling system evaluated for Canadian urban climates.



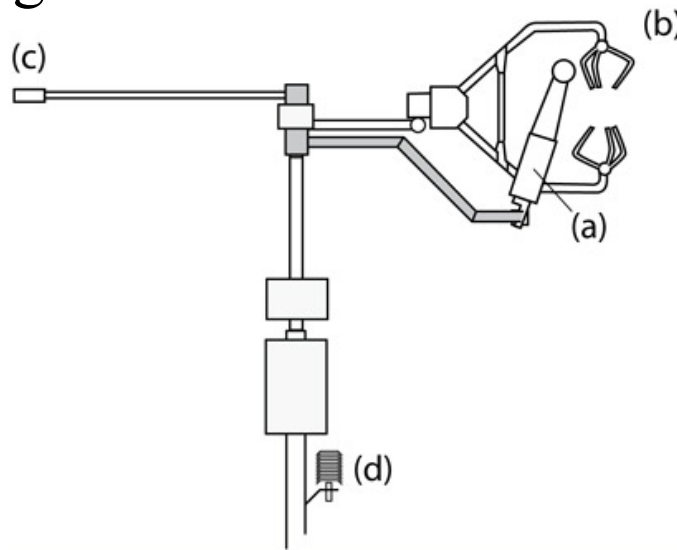
# Funding Agency Requirements

- Network must include a minimum number of partners
- International & Government partners are permitted
- Collaboration and outreach supported by budget
- Annual workshops
- All data must become public after a certain time period.



# EPiCC Observations

- Time series of atmospheric conditions.
  - Temperatures, heat, water vapour and carbon fluxes, solar and atmospheric radiation, winds, humidity
  - Sampling rates of up to 20Hz
  - Averages 5 – 30 min



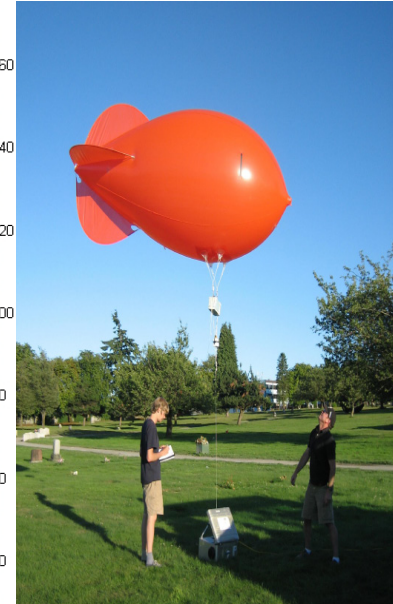
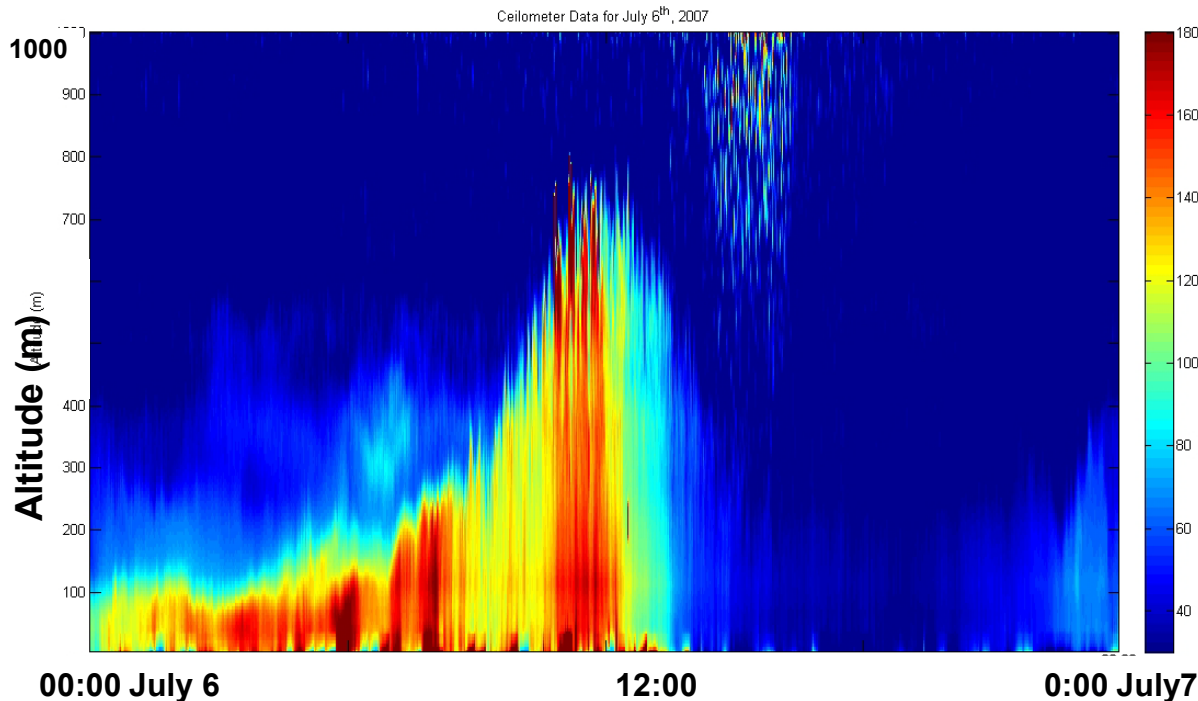
# EPiCC Observations: Profiles

- How do cities impact the boundary layer above them?
- Assess UBL height, structure and circulations through observations and modelling.



ceilometer

A. Christen

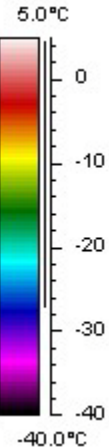
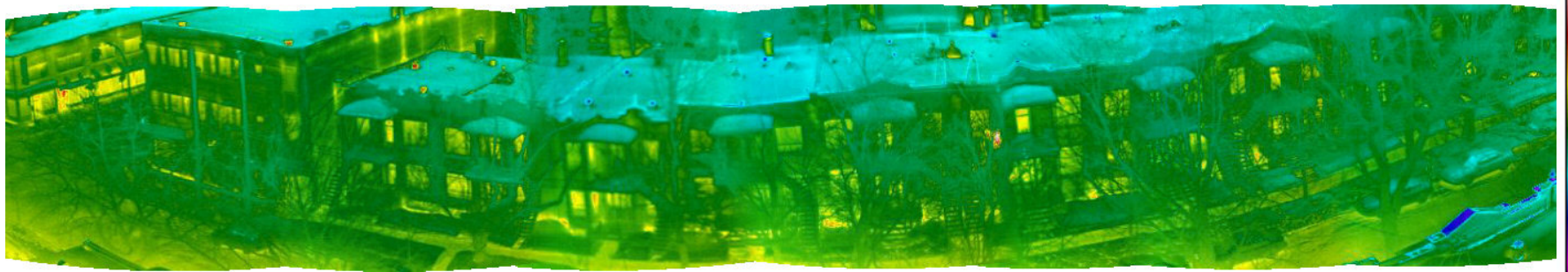
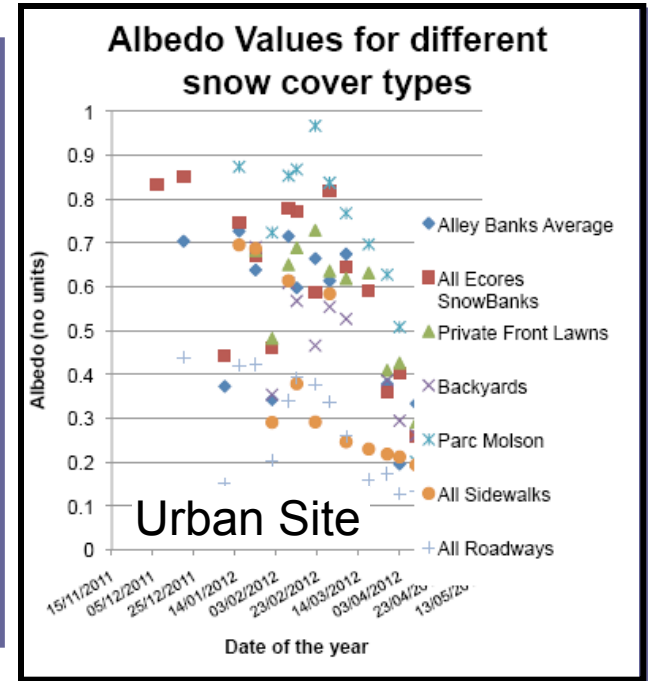


**Boundary layer height from ceilometer observations;  
Vancouver Sunset residential area**

*Images courtesy D. van der Kamp*



# EPiCC Observations: Other data types



Feb. 13, 2008; 0545-0600 EST

Clear skies,  $T_{\text{air}} = -11^{\circ}\text{C}$

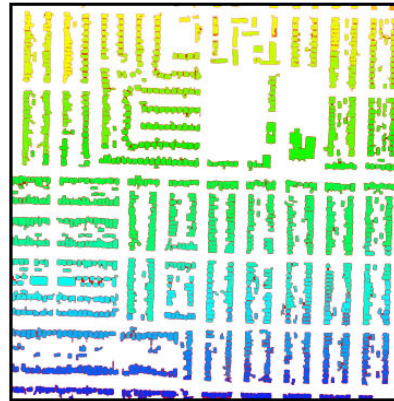
Christensen *et al.* (2009)



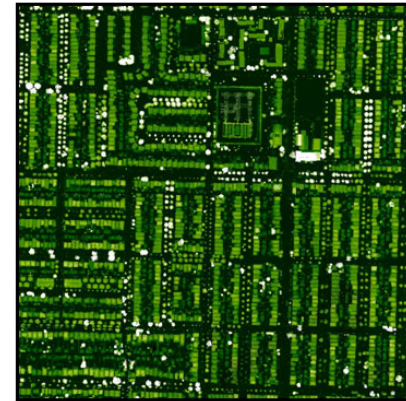
# EPiCC Observations: Surface Characteristics

- Airborne LiDAR transect
- Point density 1 per 0.7 m<sup>2</sup>
- Surface structure: built and vegetated

Isolated Building Objects

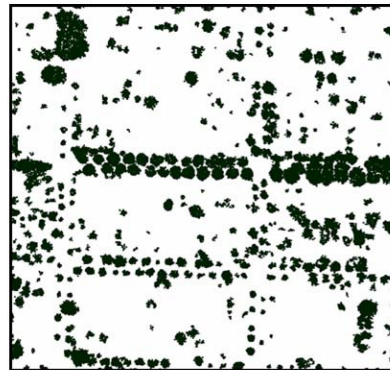


Corresponding LiDAR Derived Maximum Height Surface

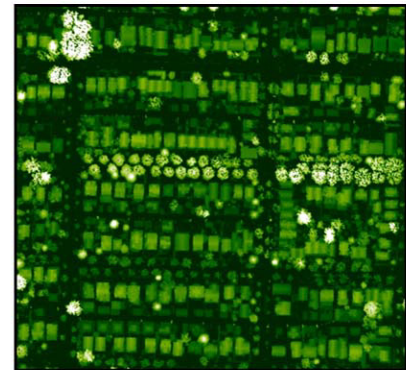


Location: Vancouver  
Area = 1 x 1 km

Extracted Vegetation Objects from LiDAR Data










Corresponding LiDAR Derived Maximum Height Surface



Location: Vancouver  
Area = 300 x 300 m

# MSC Forecasting: Global Model (33km)

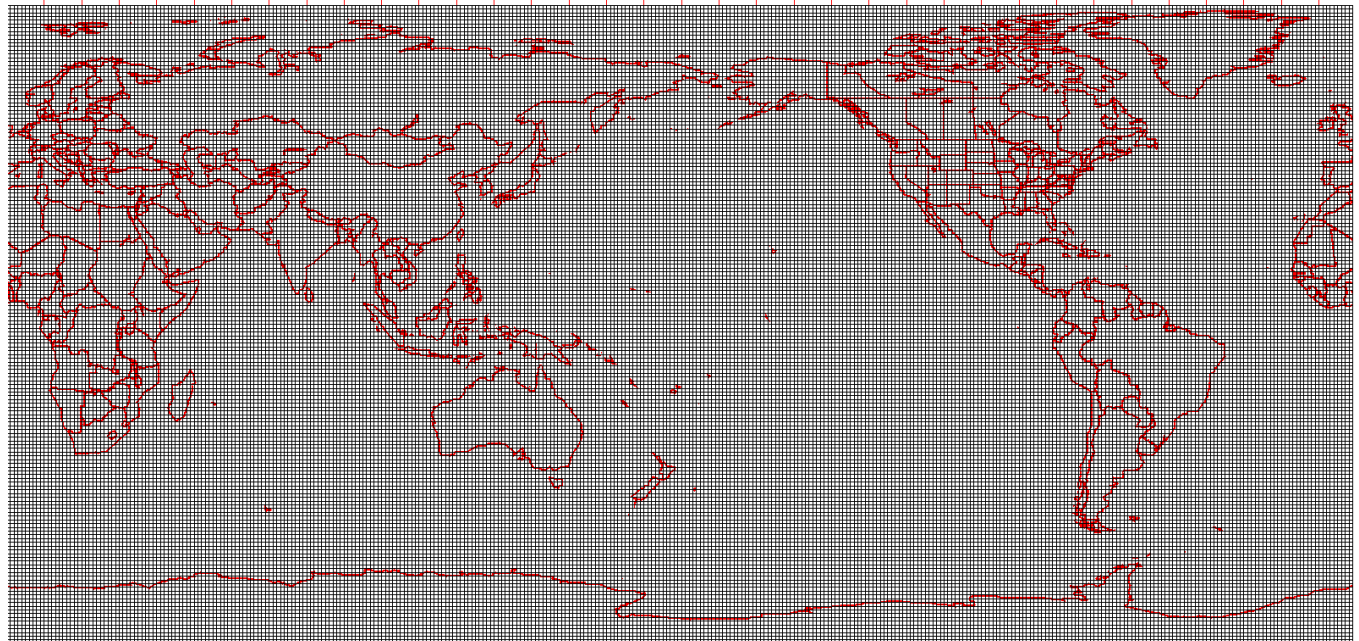
**Forecast** More info +

Tonight	Tue	Wed	Thu	Fri	Sat	Sun
						
4°C	13°C 60%	12°C 9°C	7°C 2°C	10°C -1°C	6°C 1°C 30%	7°C 2°C 30%

Issued : 3:30 PM EDT Monday 24 October 2011

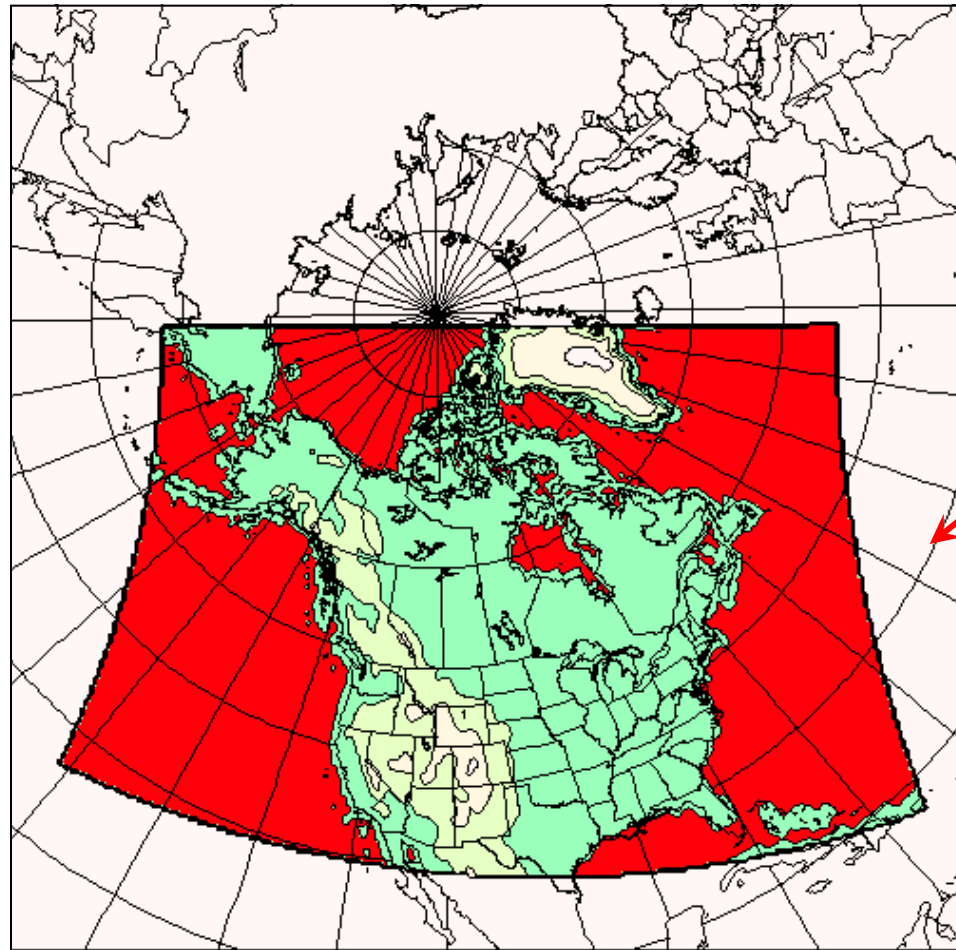
Urban Scale Forecasting

## Global Environmental Multiscale Model (GEM; 33 km)



# MSC Forecasting: Regional Model

## Regional 15-km model grid setup



Regional  
operational grid  
core:  
432x565 points

Grid projection :  
Polar stereographic



# MSC Forecasting: Local Area Model

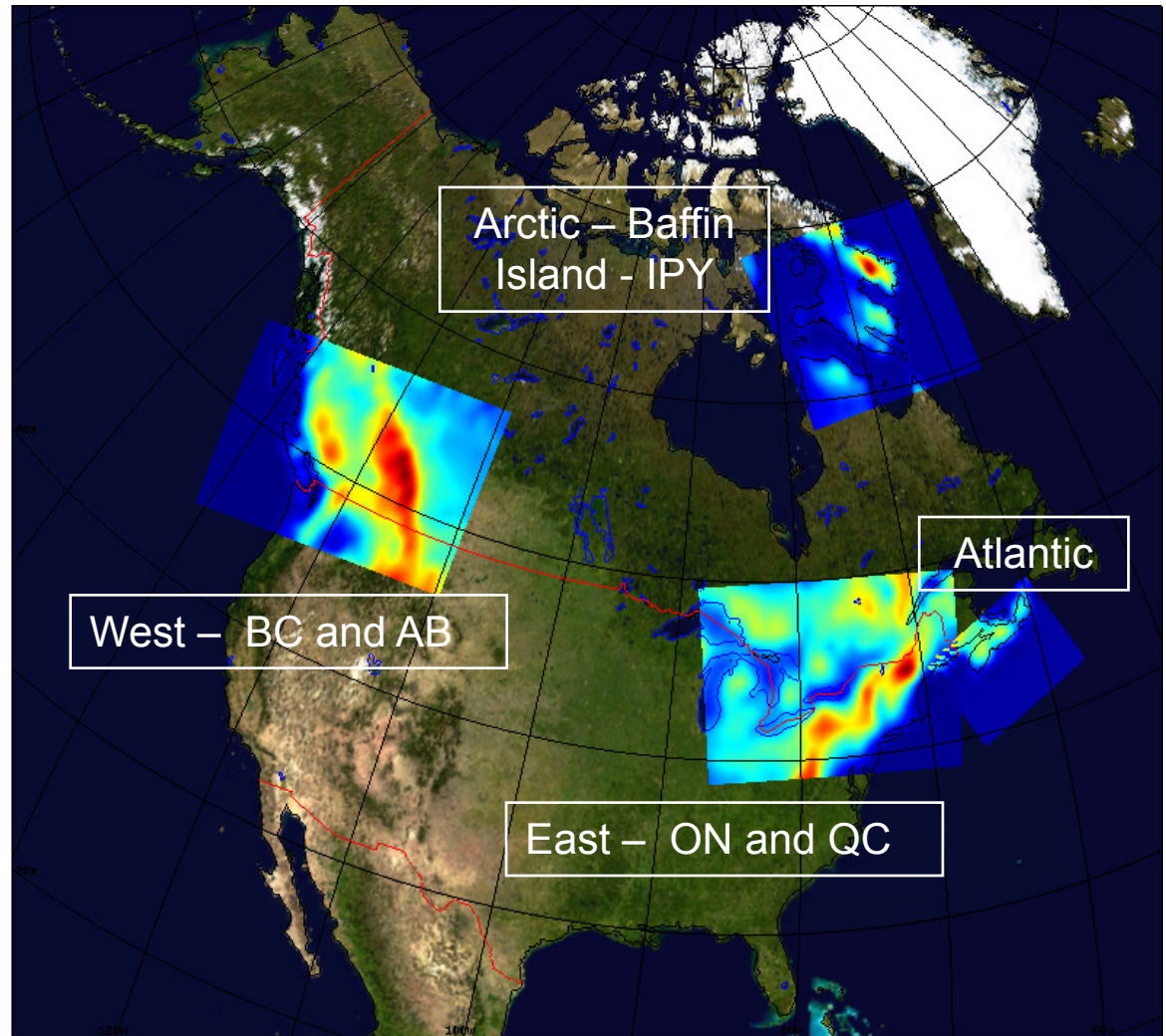
GEM LAM (Local Area Model) 2.5 km windows

**Surface Representation:  
mosaic-type approach**

**4 surface types**

- soil with vegetation and snow
- open water
- sea ice
- glaciers

**(no urban)**

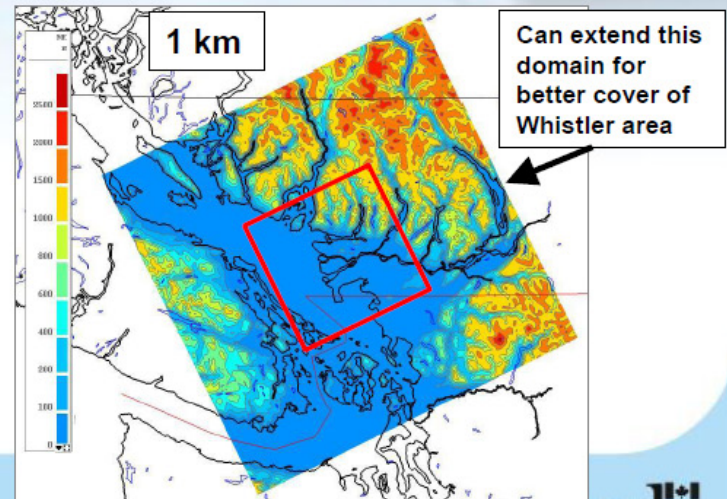
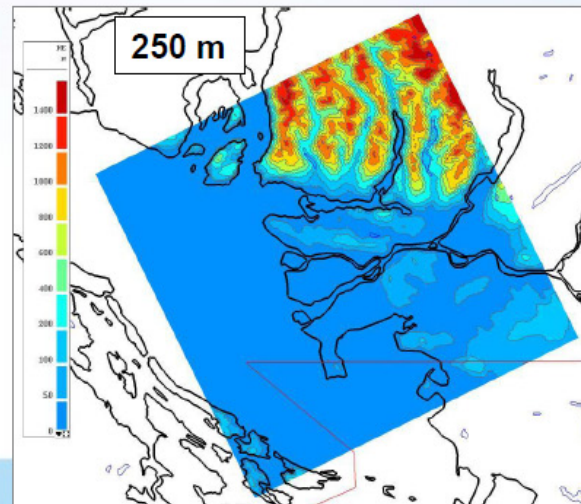
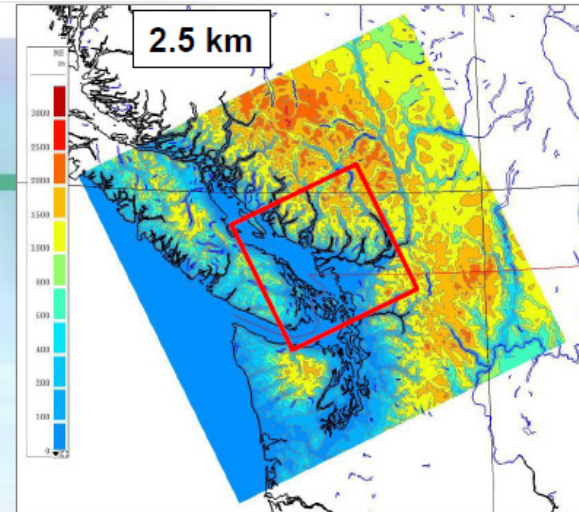


*Image courtesy J. Mailhot / Environment Canada*

# Adding the Urban Component

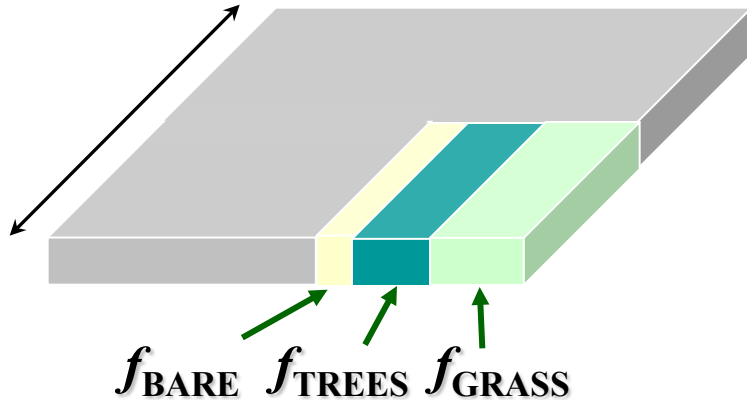
## “Urbanized” LAM at 250m - Vancouver CRTI prototype

GEM/LAM 2.5km : 200 x 200  
GEM/LAM 1km : 200 x 200  
GEM/LAM 250m : 300 x 300



# EPICC: Developing and Testing the Urban Model

Urbanized model cell

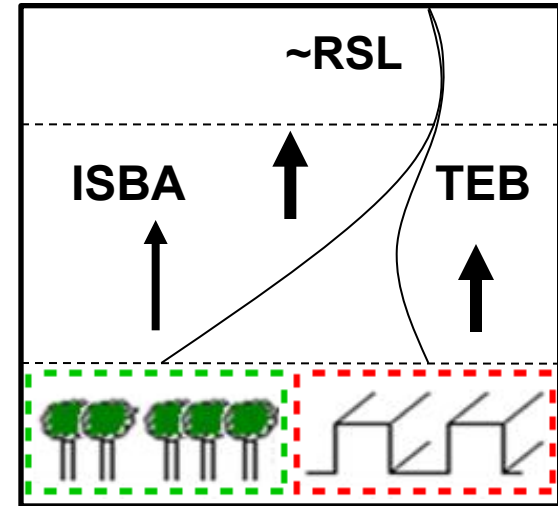


**Vegetated part:**  
**ISBA**

Noilhan & Planton  
[1989]

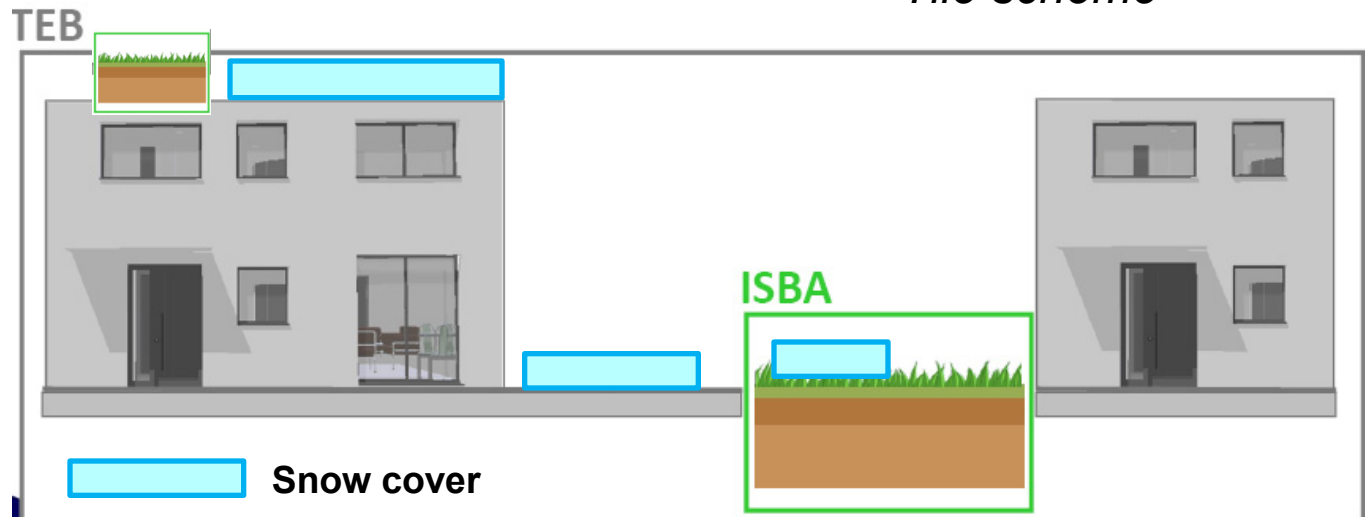
**Built part: TEB**

Masson [2000]



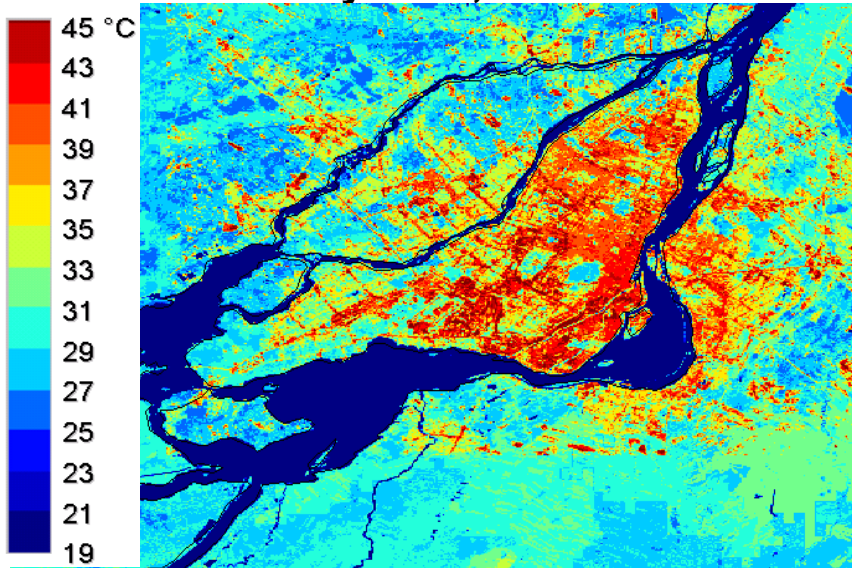
← Each urban zone →  
Tile scheme

EPICC:  
Integrate the  
vegetated and  
built components  
of the city.

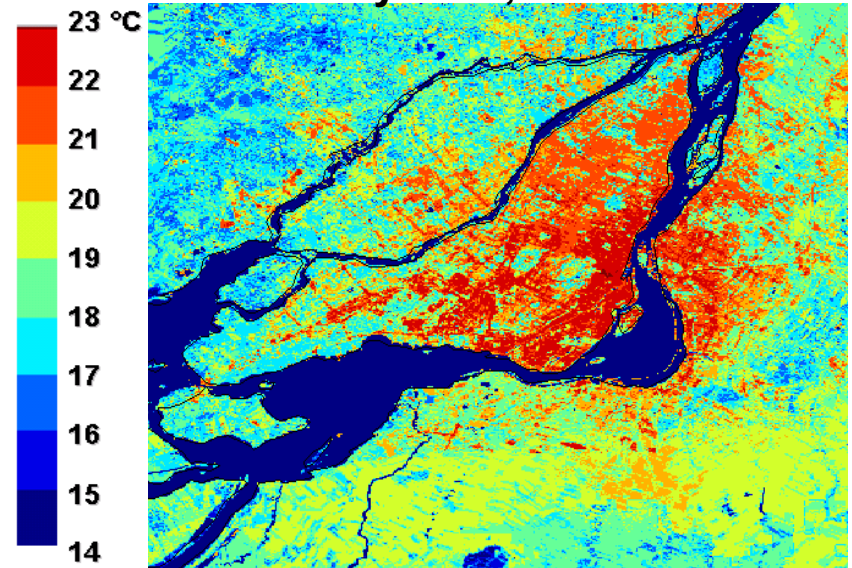


# Urban Modeling Example

**Radiative surface Temperature simulated  
on 5 July 2008, 10:00 LST**



**Screen Level Temperature simulated  
on 6 July 2008, 01:00 LST**



Application to Montreal Urban Heat Island studies for health and air quality

# Intended Outcomes

- Primary aim: to develop a version of urban surface model optimized and verified for conditions in Canadian cities and implemented in Environment Canada's modeling suite for operational forecasting
- An urban forecast tool for use in:
  - air quality/emergency response
  - weather warning systems (ice, snow, wind, flood, heat, wind chill, fog)
  - scheduling water and energy resources
  - urban design
  - assessment of climate impact and adaptation
  - heat stress and wind chill, and dispersion of air pollutants in urban environments





# EPiCC's use of technologies for communication

Home About Measurement Modelling Database Media Centre Contact

Members-Only & Admin Login

## Environmental Prediction in Canadian Cities

**Overview**

Environmental Prediction in Canadian Cities (EPiCC) is a network of scientists seeking to better understand the atmosphere in Canadian urban environments through a program of observation, remote sensing and computational modelling.

Approximately 30% of Canadians reside in cities where the near-surface atmosphere is strongly affected both by the nature of the urban surface and by anthropogenic modifications to the characteristics of the urban atmosphere.

The ultimate objective of EPiCC is to provide Canadian urban residents with an improved weather and air quality forecast system through the development of an urban-atmosphere model [TEB&ISBA], evaluated in light of information collected from Canadian urban environments

By analyzing and developing these models, EPiCC aims to enhance climatic forecasting capabilities in Canadian contexts, which in turn may contribute to the safety, health and well being of Canadians. The data EPiCC collects and the environments it models can, for example, help improve our understanding of the dispersion of smog and particulate precursors. These studies can be incorporated into procedures for anticipating heat stress, wind chill, and dispersal of air pollutants in urban environments such as accidental, industrial and terrorist releases. EPiCC studies also provide a means of tracking efforts to conserve urban resources (e.g., energy and water utilities) and identifying the most effective ways for Canadian cities to contribute to reducing greenhouse gas emissions.

EPiCC researchers are currently focusing on two Canadian cities: Montreal and Vancouver. These cities have contrasting climates and long histories in meteorological and climatological analyses, which have produced extensive databases of urban climate research. While EPiCC researchers concentrate their efforts on these two

**Updates**

Tuesday, September 27th, 2011  
New Tech Report on Historic land cover at Vancouver sites

Monday, August 15th, 2011  
Recent publications

Monday, August 8th, 2011  
EPiCC Tech. Report No. 5

Sunday, February 6th, 2011  
Montreal Sites' Characteristics and Methods Report Released!

Sunday, February 6th, 2011  
Researchers find solar savings for North Vancouver home owners

Friday, September 17th, 2010  
Rising Stars of Research 2010 – Eli Heyman – University of British Columbia

[Read more...](#)

*EPiCC's overall objective is to provide Canadian urban residents with an improved weather and air quality forecast system through the development of an urban-atmosphere model [TEB & ISBA], evaluated in light of information collected from Canadian urban environments.*

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519-661-2111 ext. 85018

## ■ Project website

- Public
- Research Community
- Participants



# EPiCC On-line Database

**EPCC**

Download  
Parameters  
**Stations**  
Datasets  
Users  
Help  
Logout

Set Time Span (format 12-4-2005 14:25)  
From  To   
Only stations that have measurements in this range are shown

**Stations with measurement times between -infinity and +infinity**

[Baseline](#)  
[London, Ontario](#)  
[Montreal Rural - 30 min data](#)  
[Montreal Rural - 5 min data](#)  
[Montreal Suburban - 30 min data](#)  
[Montreal Suburban - 5 min data](#)  
[Montreal Urban - 30 min data](#)  
[Montreal Urban - 5 min data](#)  
[Vancouver Oakridge \(Neighborhood\)](#)  
[Vancouver Rural \(Westham Island\)](#)  
[Vancouver Suburban \(Oakridge Tower\)](#)  
[Vancouver Suburban \(Sunset Tower\)](#)  
[Vancouver Sunset \(Neighborhood\)](#)

**EPCC**

Download  
Parameters  
Stations  
Datasets  
Users  
Help  
Logout

Set Time Span (format 12-Apr-2005 14:25)  
From  To    
Only parameters that have measurements in this range are shown

**Parameters with measurement times between -infinity and +infinity**

[AirTemperature](#)  
[Albedo](#)  
[BarometricPressure](#)  
[CO2Concentration](#)  
[CO2Flux](#)  
[GroundHeatFlux](#)  
[H2OConcentration](#)  
[IncomingLongwaveRadiation](#)  
[IncomingShortwaveRadiation](#)  
[LatentHeatFlux](#)  
[MixedLayerHeight](#)  
[NetRadiation](#)  
[ObukhovLength](#)  
[OutgoingLongwaveRadiation](#)  
[OutgoingShortwaveRadiation](#)  
[RainEvent](#)  
[Rainfall](#)  
[RelativeHumidity](#)  
[SensibleHeatFlux](#)  
[SnowDepth](#)  
[SoilTemperature](#)  
[SoilWaterContent](#)  
[SurfaceTemperature](#)  
[TurbulentKineticEnergy](#)  
[uStar](#)  
[UWindStandardDeviation](#)  
[VWindStandardDeviation](#)  
[WindDirection](#)  
[WindSpeed](#)  
[WWindStandardDeviation](#)

- Registered Users
- Select by Station
- Select by Parameter



# Benefits of Free Information Exchange

- In urban climate research there are:
  - Many modelling groups
  - Few observation groups (and good field campaigns are increasingly multi-institutional due to logistics and costs involved)
  - Good observations are therefore in demand e.g. for evaluation of model developments – multiplies use of original data – sometimes by many times.
  - Good observations may have a legacy lasting decades



# Participation in Research Community

## International Association for Urban Climate

Association for those interested in climatology and meteorology of built up areas

International Association for Urban Climate: *Urban Climate News*

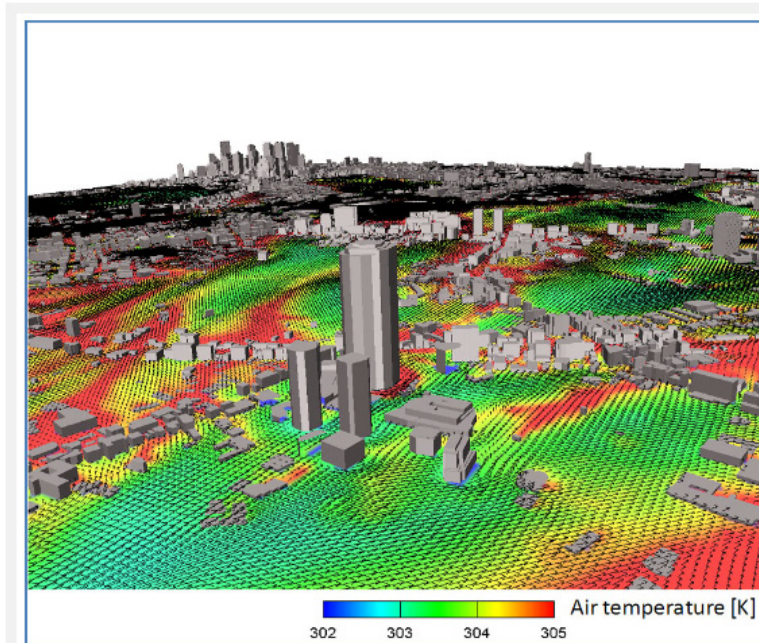
Reaches over 1500 on-line readers (digital only)

IAUC a *free* association



### Urban News 41

Posted on August 13, 2011 by Stephanie Halpin



#### Meetings

- Upcoming Meetings
- Past Meetings

#### Recent Posts

- Urban News 41

#### Newsletters

- September 2011
- June 2011
- March 2011
- December 2010
- September 2010
- June 2010
- March 2010
- December 2009

#### IAUC



# Participation in Research Community

International Association for Urban Climate: Urban Flux Network

Site Index  
Information for research community users



[| Feedback](#) | [Add a new site](#) | [Urbanflux Mailing List](#) |

Sites directory

<input type="radio"/>	Montreal Rue des Ecores	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/>	Montreal Rue Fabre	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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<input checked="" type="radio"/>	Nantes SAP / ONEVU	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/>	Rome Collegio Romano	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="radio"/>	Salt Lake City Murray	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="radio"/>	Singapore Telok Kurau	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="radio"/>	Syracuse Center of Excellence	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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<input type="radio"/>	Vancouver Light Industrial	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Interactive Map - Click on markers to display site details



- Energy Balance
- Carbon Dioxide Fluxes
- Aerosol Fluxes
- Other Trace Gas Fluxes
- Active site

This database is provided by the International Association for Urban Climate  
Hosted by the Department of Geography, University of British Columbia

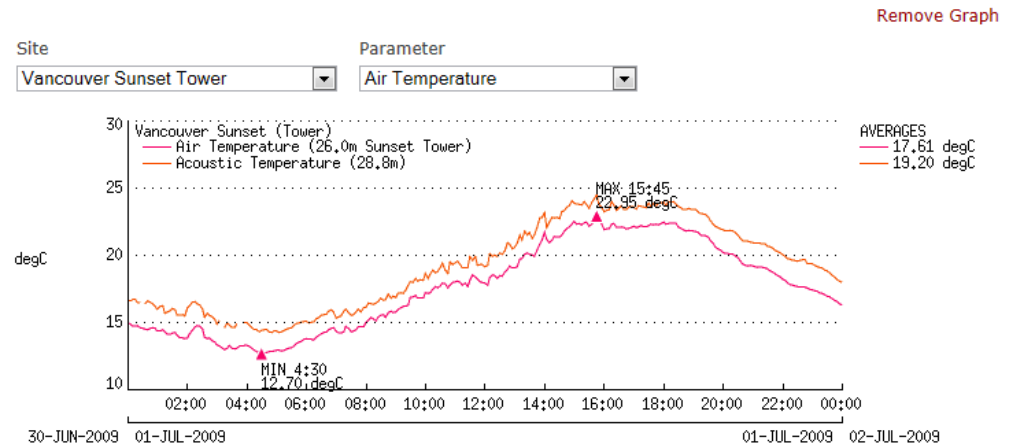
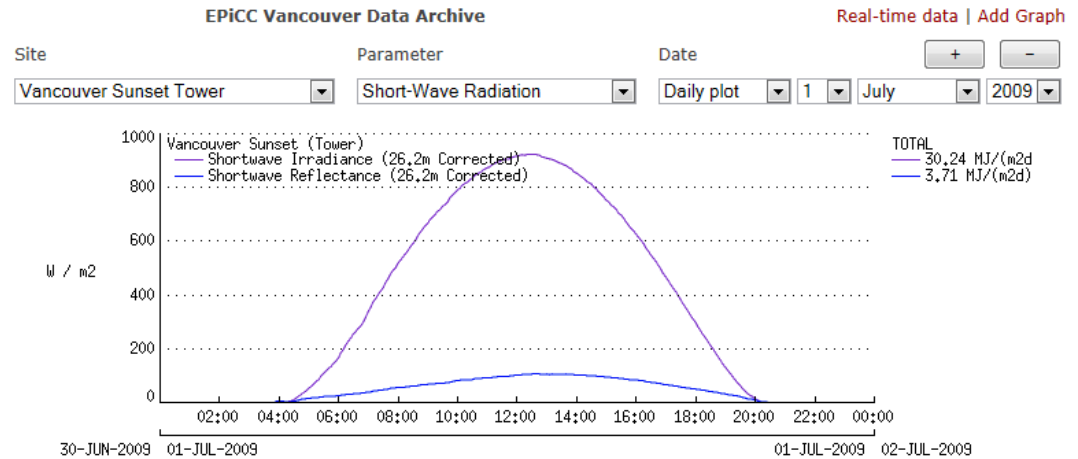


2.361c



# Impact of Technologies on Research

- Web-interface to data plots for quick view and assessment
- Potential users can quickly assess availability of data for their needs.

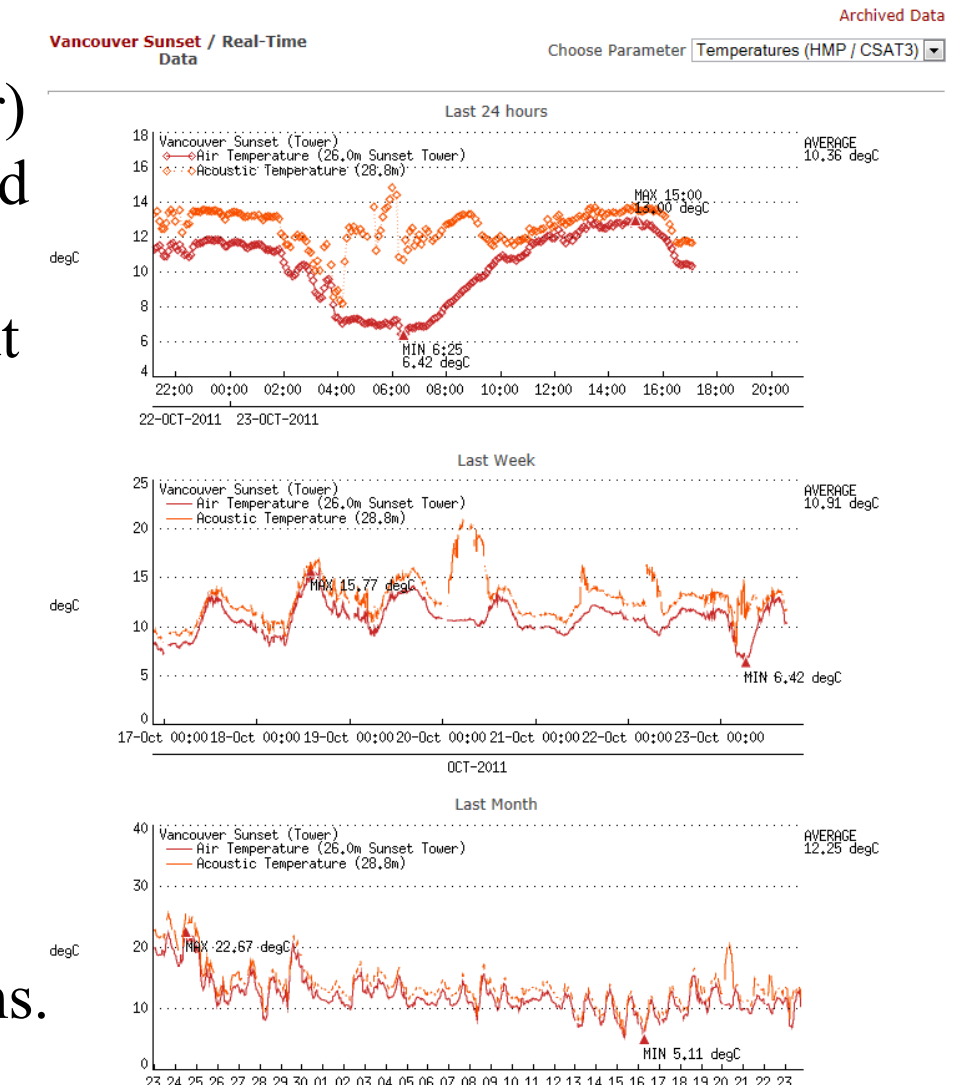


University of British Columbia - andreas.christen@ubc.ca



# Impact of Technologies on Research Practice

- Technology allows for (near) real time data to be displayed and saved.  
Time to availability (sec) but no QC/QA
- Requires additional infrastructure
- Potential new users/applications
- Normal practice: off-line collection and processing  
Time to availability – months.

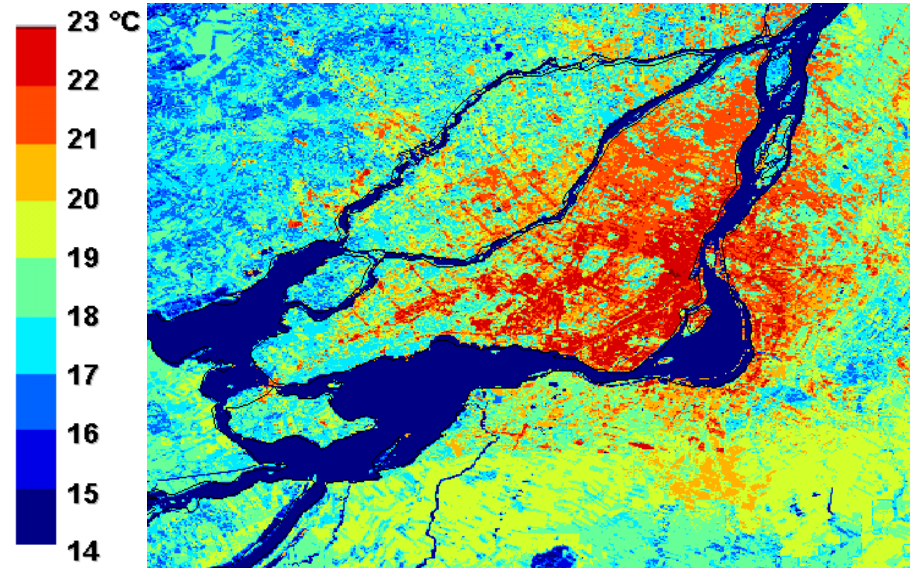


# Impacts of Technologies on Research Practice

- Use of remote facilities – e.g. Env Canada modeling system. Firewalls, data storage etc.
- Access to the model for users?
- Future forecasts – links to customized cell phone delivery



UWO Green Roof Test Site



Urban Scale Modeling of Green Roof Deployments





# Special thanks to

- A. Christen (UBC Geography)
- T.R. Oke (UBC Geography)
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- I. McKendry (UBC Geography)
- B. Nanni (UWO)
- I. Strachan (McGill)
- F. Chagnon (Env. Canada, Quebec Region)

*and*

the entire EPiCC team



*Visit us online at  
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