New EC Research Initiatives in the Great Lakes Region

Dave Sills
Cloud Physics and Severe Weather Research Section / MRD / S&T
+ Nowcasting and Remote Sensing Meteorology (NoRM) Lab

Photo: Jonathan Ponce
Outline

• 2015 Pan / ParaPan American Games
  – Quick Overview

• Research ‘Showcase’ Activities
  – Mesonet / NWP
  – Lightning
  – Next Generation Weather Office Demo

• EF-scale at EC
  – if time
2015 Pan / ParaPan Am Games

- To take place in the ‘Greater Golden Horseshoe’ region surrounding Toronto Jul-Aug 2015
- More outdoors venues and athletes than the Olympic Games
- EC operations will provide enhanced safety and security services
  - e.g., point-based warnings for venues
- Also several related ‘showcase’ research initiatives…
EC ATMOS Surface Mesonet Stations

x 10 units
EC AMMOS Mobile Mesonet Stations

x 3 units
EC AMMOS Mobile Mesonet Stations

Dufferin Yonge

1 2 3 Warden
Ultra High-Resolution NWP

- 250m grid spacing computational domain
- About 800x800 (200km x 200km)
- Integrated four times per day
- 24h integrations
Lightning Mapping Array

- Lightning mapping array (LMA) being acquired by EC from New Mexico Tech
- Will give 3D coverage over all of GTA, 2D coverage over most of south-central Ontario
- Research system – will be deployed 2014-2018 (covering Pan Am Games period)
- IC lightning should give lead time on first CG
- Total lightning trends are closely associated with updraft strength – anticipate better lead times for severe weather warnings
Lightning Mapping Array

- New Mexico Tech LMAs have been installed in several US locations (e.g. Washington D.C.) – Toronto will be first in Canada
MSC ‘Signature Projects’ require:

- New forecasting, nowcasting and alerting tools that facilitate the best application of human skills and enable optimal use of technological progress to improve detection and prediction

- To better define exactly how forecasters will use these new tools during a shift (‘Concept of Operations’) to ensure effective interaction with the forecast database

- To improve efficiency via automated product generation

- New watch/warning products and dissemination approaches to provide improved, more impact-based decision support to Canadians and to public authorities

- To integrate wherever possible with MSC NinJo Workstation
Objectives

For the Next Generation Forecast and Warning Process Demonstration Project:

• Demonstrate an event-based, multi-scale (spatial and temporal) approach to forecasting, nowcasting and alerting focused on warm season mesoscale features and high-impact weather

• Demonstrate how MetObjects facilitate forecaster interaction with high-resolution forecast databases and enhance forecaster analysis / diagnosis / prognosis (ADP)

• Demonstrate the potential for increased efficiencies via the automated generation of a wide variety of cutting-edge products from the MetObject database
What exactly are ‘MetObjects’?

- MetObjects can be used to greatly simplify complex weather features.
- Can use points, lines, areas, tracks to represent storm cells, fronts / jets, threat areas, storm tracks.
- Enables ‘knowledge representation’ in a digital database using conceptual models as building blocks.
- Very intuitive for forecasters, able to use extensive library of conceptual models: enhances analysis / diagnosis / prognosis process.
Nex Gen Prediction Process

- High-Res NWP
  - Advanced Post-Processing
  - First-Guess MetObjects
  - High-Res Monitoring

- AI Algorithms

- Forecaster Interface

- MetObject Database
  - Performance Measurement

- Forecast Products
  - Automated HIW Products
  - Automated Forecast Products
  - Automated Verification Products
Nex Gen Prediction Process

- High-Res NWP
- Advanced Post-Processing
- First-Guess MetObjects
- High-Res Monitoring

- 250 m HRDPS
- 60 Station Mesonet
- Satellite
- Radar
- Lightning
Synoptic / Mesoscale

MetObject depictions:

- Synoptic-scale and mesoscale features important for convection based on observations, NWP, conceptual models, etc.
- Probabilistic areas for thunderstorm likelihood and severity
- Series of depictions from T0 (analysis) to T0+48
Storm-Scale

- New approach to severe thunderstorm nowcasting and alerting
- Forecaster manages track MetObjects / intensity trends for significant storms
- Alerts derived from MetObjects
Storm-Scale

- Developing an interactive Storm Attributes Table
- Provides an extrapolated composite ‘rank weight’
- Can turn off / modify parameter values then recalculate rank and intensity trend
Product Generation

- Automated HIW Products
- Automated Forecast Products
- Automated Verification Products

Probabilistic Thunderstorm Nowcast
Product Generation

Verification Using Lightning Obs

Automated HIW Products

Automated Forecast Products

Automated Verification Products
SEVERE THUNDERSTORM WARNING FROM ENVIRONMENT CANADA AT 7:10 PM EDT THURSDAY 28 JULY 2012.

SEVERE THUNDERSTORM WARNING FOR:
=NEW= GODERICH – BLUEWATER – SOUTHERN HURON COUNTY

A SEVERE THUNDERSTORM PRODUCING LARGE HAIL, DAMAGING WINDS AND HEAVY RAIN 10 KM SOUTHEAST OF GODERICH IS MOVING SOUTHEAST AT 40 KM/H. THIS STORM IS EXPECTED TO REACH SEAFORETH AT 8:05 PM EDT.
Implementation

Dual ‘Research Support Desks’ in OSPC ‘Pan Am Area’:

- RSD1 – Graphical prognoses and outlooks for thunderstorms / severe weather derived from the MetObject forecast database
- RSD2 – Graphical mesoscale analyses, storm-scale nowcasts, and severe weather threat areas derived from the MetObject nowcast database
- Real-time demonstration!
Anticipated Benefits

- Forecasters focus on meteorology, not the details of product generation – *better situational awareness*
- Automated generation of many products from forecaster-modified database – *greater efficiency*
- Enhances ability to employ conceptual models – *better use of extensive forecaster training*
- Products with more precision, greater utility, longer lead times
- Can use new and emerging object-based verification to provide near real-time feedback
Enhanced Fujita Scale @ EC

<table>
<thead>
<tr>
<th>F/EF Rating</th>
<th>F-Scale Wind Speed Rounded to 10 km/h</th>
<th>EF-Scale Wind Speed Rounded to $5 \text{ km/h}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>60 – 110</td>
<td>90 – 130</td>
</tr>
<tr>
<td>1</td>
<td>120 – 170</td>
<td>135 – 175</td>
</tr>
<tr>
<td>2</td>
<td>180 – 240</td>
<td>180 – 220</td>
</tr>
<tr>
<td>3</td>
<td>250 – 320</td>
<td>225 – 265</td>
</tr>
<tr>
<td>4</td>
<td>330 – 410</td>
<td>270 – 310</td>
</tr>
<tr>
<td>5</td>
<td>420 – 510</td>
<td>315 or more</td>
</tr>
</tbody>
</table>

- Main difference is wind speed relationship
If *power law* regression used instead of *linear*:

- better fit
- goes through origin
- lower bound of EF0 becomes ~90 km/h instead of 105 km/h

After McDonald and Mehta (2006)
# 31 Damage Indicators

<table>
<thead>
<tr>
<th>Number</th>
<th>Damage Indicator (DI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Small Barns or Farm Outbuildings (SBO)</td>
</tr>
<tr>
<td>2</td>
<td>One- or Two-Family Residences (FR12)</td>
</tr>
<tr>
<td>3</td>
<td>Manufactured Home: Single Wide (MHSVA)</td>
</tr>
<tr>
<td>4</td>
<td>Manufactured Home: Double Wide (MHDW)</td>
</tr>
<tr>
<td>5</td>
<td>Apartments, Condos, Townhouses (ACT)</td>
</tr>
<tr>
<td>6</td>
<td>Motel (M)</td>
</tr>
<tr>
<td>7</td>
<td>Masonry Apartment or Motel (MAM)</td>
</tr>
<tr>
<td>8</td>
<td>Small Retail Building (SRB)</td>
</tr>
<tr>
<td>9</td>
<td>Small Professional Building (SPB)</td>
</tr>
<tr>
<td>10</td>
<td>Strip Mall (SM)</td>
</tr>
<tr>
<td>11</td>
<td>Large Shopping Mall (LSM)</td>
</tr>
<tr>
<td>12</td>
<td>Large, isolated Retail Building (LIRB)</td>
</tr>
<tr>
<td>13</td>
<td>Automobile Showroom (ASR)</td>
</tr>
<tr>
<td>14</td>
<td>Automobile Service Building (ASB)</td>
</tr>
<tr>
<td>15</td>
<td>Elementary School (ES)</td>
</tr>
<tr>
<td>16</td>
<td>Junior or Senior High School (JSHS)</td>
</tr>
<tr>
<td>17</td>
<td>Low-Rise Building: 1 - 4 Storeys (LRB)</td>
</tr>
<tr>
<td>18</td>
<td>Mid-Rise Building: 5 - 20 Storeys (MRB)</td>
</tr>
<tr>
<td>19</td>
<td>High-Rise Building: Greater than 20 Storeys (HRB)</td>
</tr>
<tr>
<td>20</td>
<td>Institutional Building (IB)</td>
</tr>
<tr>
<td>21</td>
<td>Metal Building System (MBS)</td>
</tr>
<tr>
<td>22</td>
<td>Service Station Canopy (SSC)</td>
</tr>
<tr>
<td>23</td>
<td>Warehouse Building (WBB)</td>
</tr>
<tr>
<td>24</td>
<td>Free-Standing Towers (FST)</td>
</tr>
<tr>
<td>25</td>
<td>Free-Standing Light Poles, Luminary Poles, Flag Poles (FSP)</td>
</tr>
<tr>
<td>26</td>
<td>Electrical Transmission Lines (ETL)</td>
</tr>
<tr>
<td>27</td>
<td>Trees (T)</td>
</tr>
<tr>
<td>28</td>
<td>Heritage Church (HC)</td>
</tr>
<tr>
<td>29</td>
<td>Solid Masonry House (SMH)</td>
</tr>
<tr>
<td>30</td>
<td>Farm Silos or Grain Bins</td>
</tr>
<tr>
<td>31</td>
<td>Sheds, Fences or Lawn Furniture (SFLF)</td>
</tr>
<tr>
<td></td>
<td>Farms / Residences</td>
</tr>
<tr>
<td></td>
<td>Commercial / retail structures</td>
</tr>
<tr>
<td></td>
<td>Schools</td>
</tr>
<tr>
<td></td>
<td>Professional buildings</td>
</tr>
<tr>
<td></td>
<td>Metal buildings / canopies</td>
</tr>
<tr>
<td></td>
<td>Towers / poles</td>
</tr>
<tr>
<td></td>
<td>Canadian DI's</td>
</tr>
</tbody>
</table>
Acknowledgments

• Norbert Driedger
• Brian Greaves
• Emma Hung
• Bill Burrows
• Bob Paterson
• Stephane Belair

• Helen Yang
• Karen Haynes
• Rob Reed
• Paul Joe
• Joan Klaassen
• John MacPhee
• Rob Simpson