Responsive Traffic Management Through Short-Term Weather and Collision Prediction

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❑ Introduction
❑ Weather-Responsive Traffic Management (WRTM)
❑ City of Edmonton Weather and Collision Prediction
❑ Benefits
❑ Next Steps

City of Edmonton Office of Traffic Safety (OTS)

http://www.edmonton.ca/transportation/traffic-safety.aspx

- Established in 2006 as a result of Mayor Traffic Safety Task Force
- Focus on urban traffic safety through evidence-based approaches

Shifting Rural to Urban World Population (UN Report 2009):

Year	Urban Population	Rural Population
2009	**3.4** billion	**3.4** billion
2050	**6.3** billion	**2.9** billion

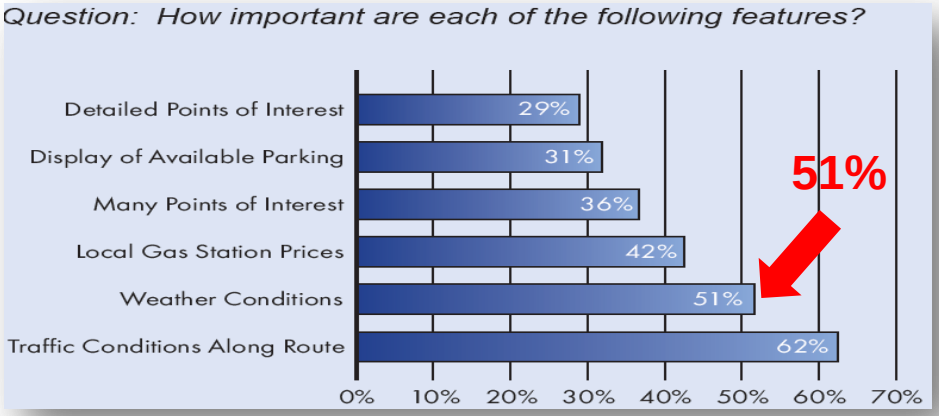
- The OTS will reduce the prevalence of fatal, injury, and property damage collisions through the **4 E**'s of traffic safety (**E**ngineering, **E**ducation, **E**nforcement, and **E**valuation) by improving
  - urban traffic safety engineering
  - road user behaviour
  - speed management and
  - data, business intelligence and analytics

Weather Impacts on Safety and Mobility

- US DOT Road Weather Management Program:[1]
  - In US, over 5,870,000 vehicle collisions each year - 23% (nearly 1,312,000) are weather-related.
  - On average, 6,250 fatalities and over 480,000 injuries in weather-related collisions each year.
  - 23 percent of the non-recurrent delay on highways across the US is due to snow, ice, and fog ≈ 544 million vehicle-hours of delay per year.

- Weather-related collision costs in Canada are estimated to be approximately $1 billion per year. [2]

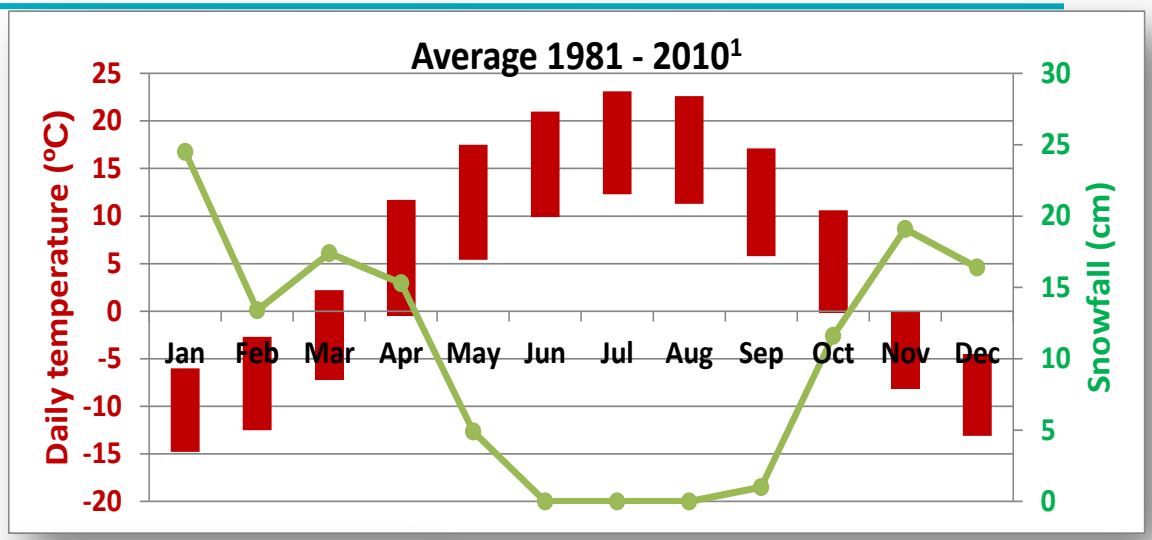
- Survey indicated the importance of information on weather conditions for travelers.[3]

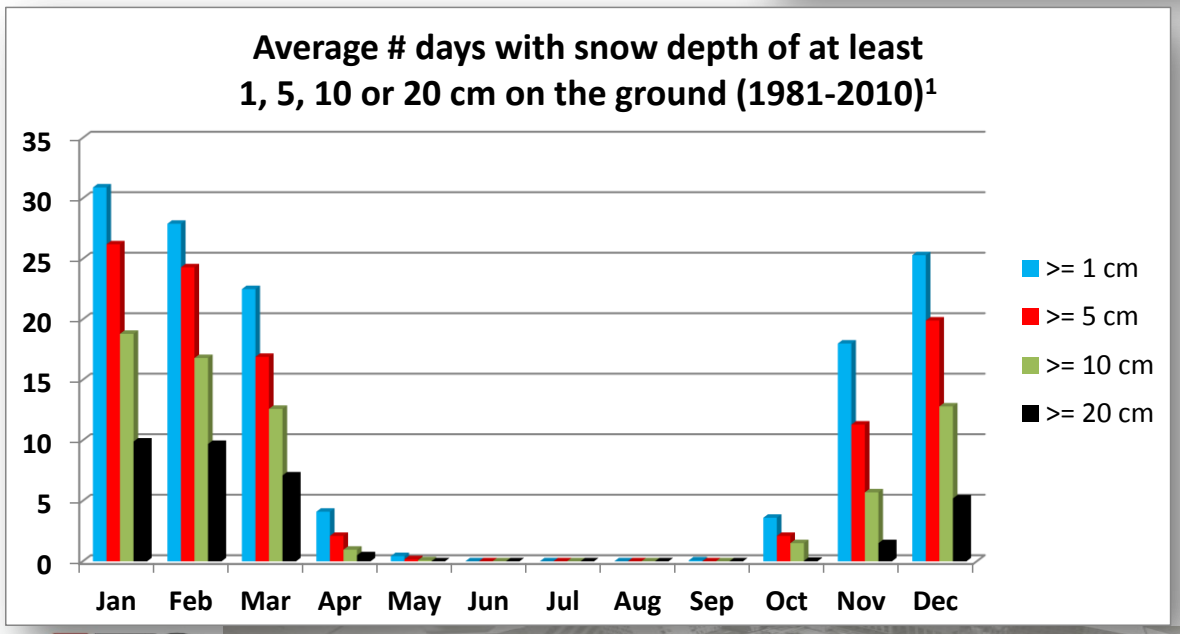


[1] http://www.ops.fhwa.dot.gov/weather/q1_roadimpact.htm; accessed on May 15, 2014.
[2] Andrey, J., B. Mills, and J. Vandermolen. Weather Information and Road Safety: Final Report. Final Report Presented to the Institute for Catastrophic Loss Reduction, 2001. Downloadable from http://www.iclr.org/images/Weather_information_and_road_safety.pdf.
[3] Federal Highway Administration. US Department of Transportation. Weather-Responsive Traffic Management: New Approaches to Improve Safety and Mobility. (Spring 2011). FHWA-JPO-11-093.

Weather in Edmonton

- Throughout the year, temperatures can range from below -40°C during the winter, to above 30°C in the summer.



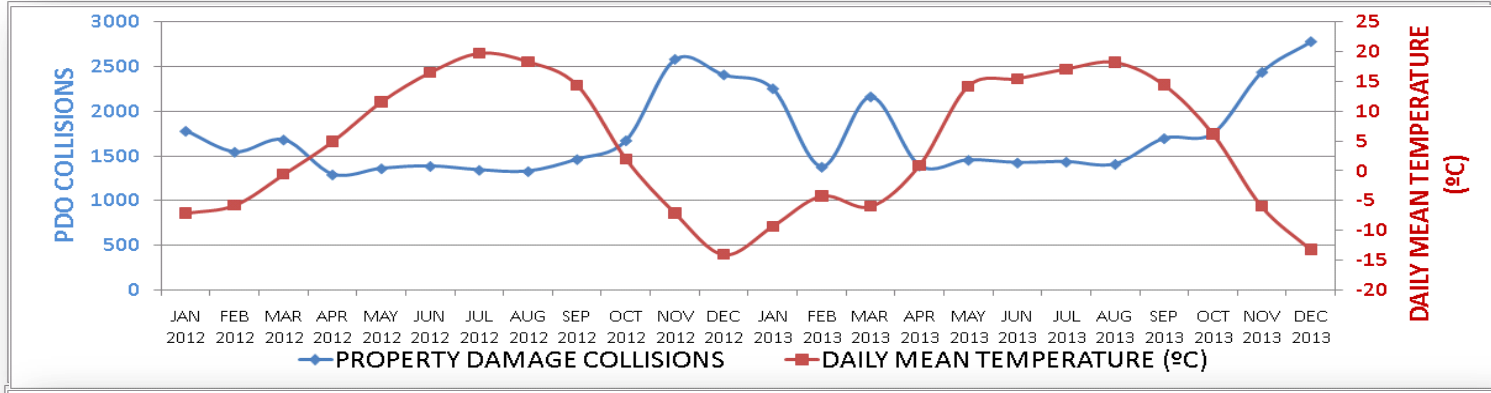


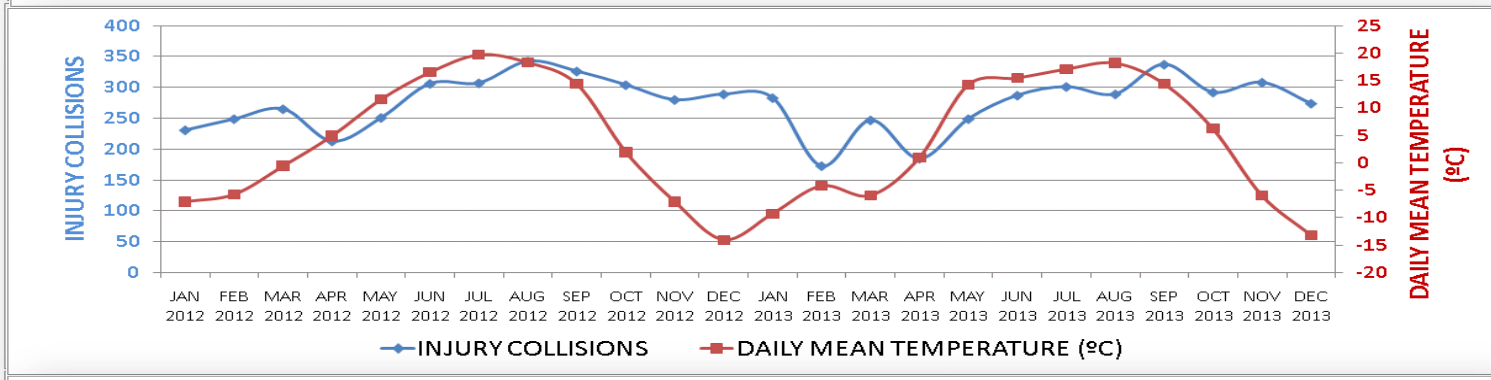
- In the City of Edmonton, around 57% of collisions occurred in the fall and winter months (January - March and October - December).[2]

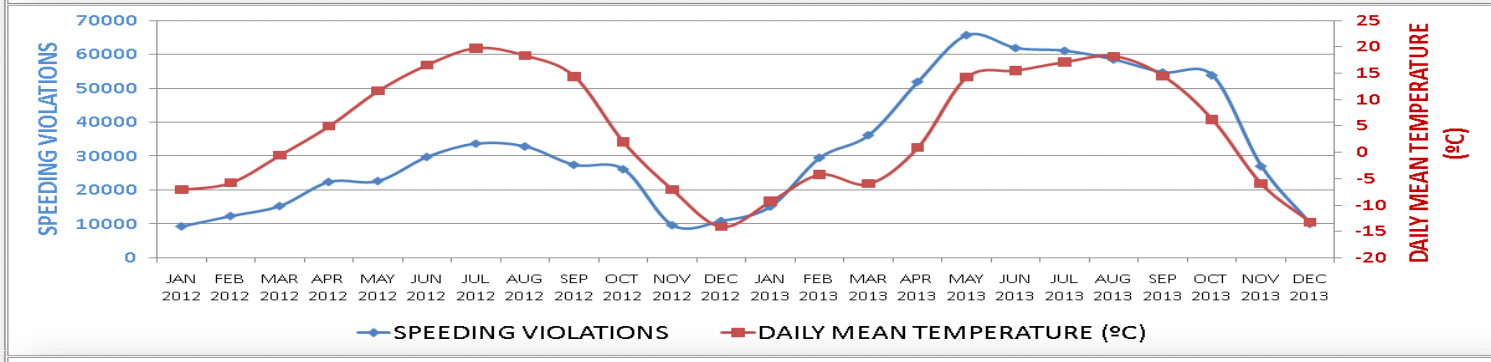
[1]1981-2010 Climate Normals & Averages http://climate.weather.gc.ca/climate_normals/index_e.html

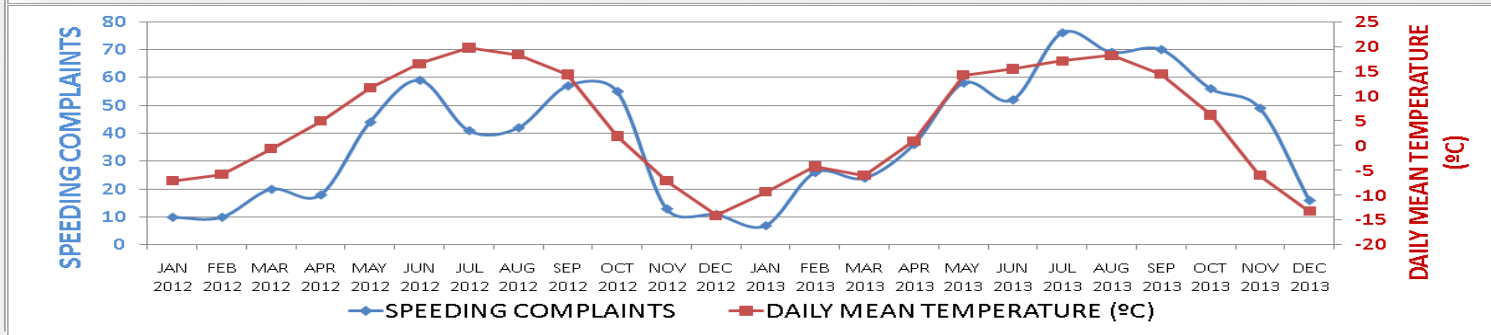
[2]City of Edmonton annual motor vehicle collision reports. Downloadable from http://www.edmonton.ca/transportation/traffic_reports/collision-speed-reports.aspx.

Weather Impacts on Traffic Safety: Trends and Patterns









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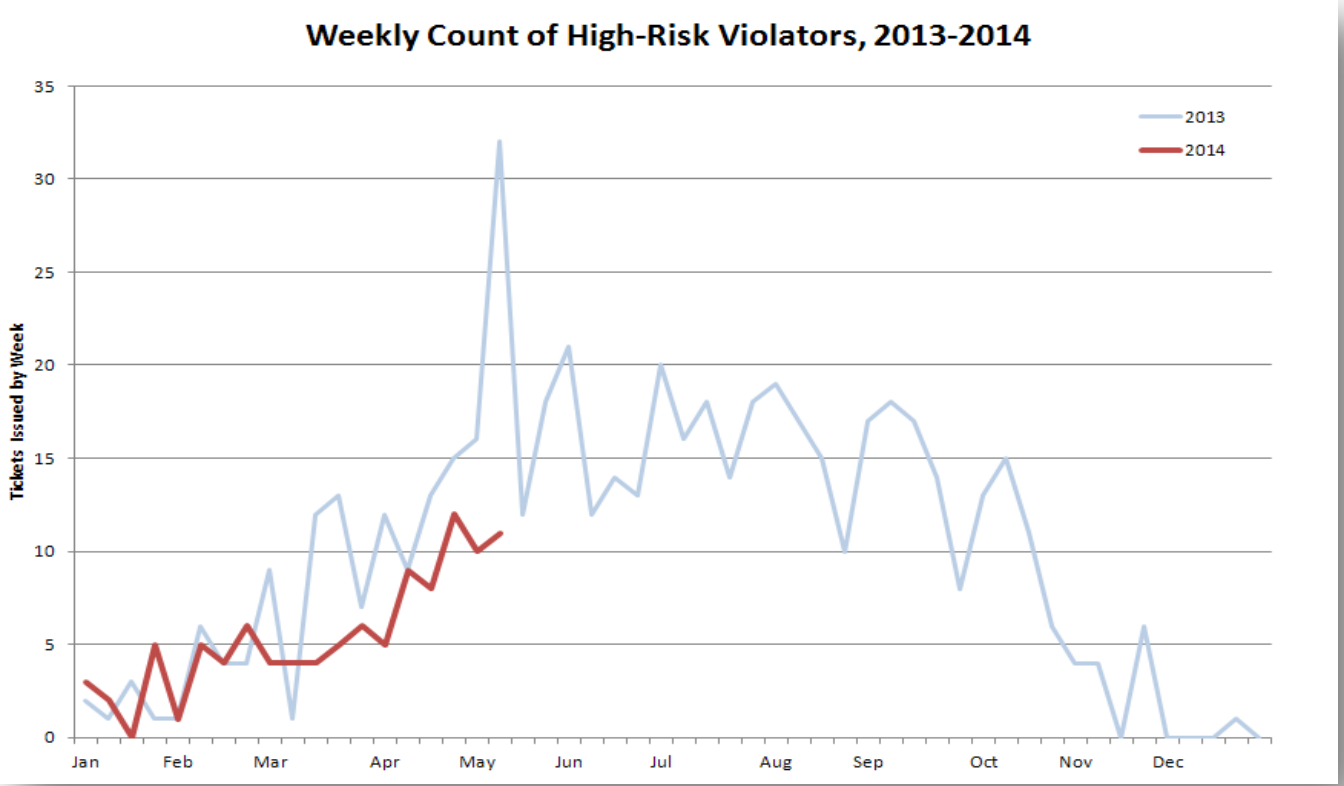
Weather Impacts on Traffic Safety



Weather impact on collision[1]:

- Min Temp<-10, Total Snow>0 and Speed of Max Gust >20 increased FTC (Followed Too Closely) collisions between 17.9% and 33.0%.

[1]El-Basyouny, K., Barua, S., Islam, Md.T., Li, R. 2014. Assessing the Effect of Weather States on Crash Severity and Type using Full Bayesian Multivariate Safety Models. TRB 93rd Annual Meeting Compendium.

Weather-Responsive Traffic Management (WRTM)

- Goal[1]: to minimize the delay and risk experienced by motorists while driving in bad weather.
- Strategies[1]:
  - Advisory strategies provide warning and other information to travelers;
  - Control strategies to regulate or optimize traffic flow; and
  - Treatment strategies to ensure the roads are clear of obstructions
- Implementation: Integrated Transportation Management Centre

Increase access, mobility and safety

- WRTM
- Congestion management
- Advanced Traveler Information System (ATIS)
- Situational awareness and planning functionality
- Emergency operations centre capability

[1]Federal Highway Administration. US Department of Transportation. Weather-Responsive Traffic Management: Real Solutions for Serious Traffic Problems. FHWA-JPO-09-035.

WRTM - City of Edmonton's Initiative

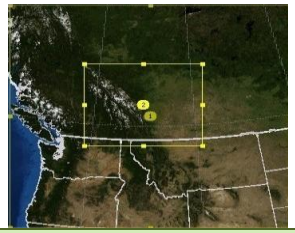
- Building 6 new weather stations collecting/calculating:
  - Wind speed and direction
  - Barometer pressure
  - Snow and rain fall
  - Air temperature and humidity
  - Dew point

- Weather, collision and traffic flow (volume & speed) prediction:
  - Current state: 7 days ahead prediction of citywide daily weather and collision
  - Collision prediction: public roadway collisions and police-call (CAD) collisions
  - Collaborators:

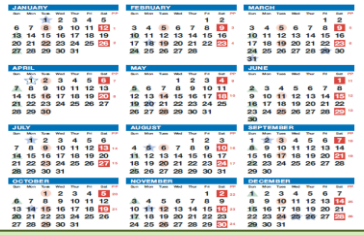
    - ✓ Weather prediction: Department of Earth and Atmospheric Sciences, University of Alberta
    - ✓ Collision and traffic flow prediction: City of Edmonton Office of Traffic Safety
    - ✓ Web-base application: Department of Civil and Environmental Engineering, University of Alberta

  - Current users: the Edmonton Police Service and City of Edmonton Office of Traffic Safety

City of Edmonton Weather, Collision and Traffic Flow Prediction

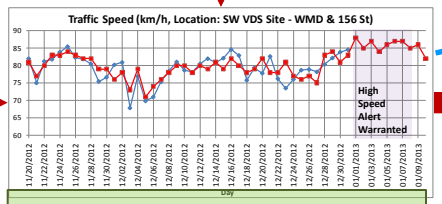


Weather Data
Set-up for Edmonton



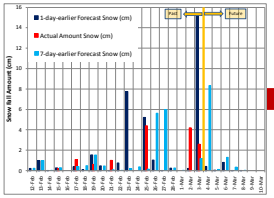
Calendar Data
Month, Day of Week, Holiday

Traffic Flow Data
VDS Sites: Speed, Volume

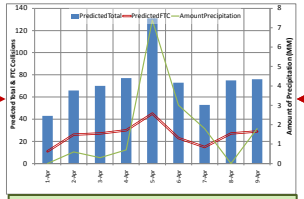


Volume & Speed
Prediction

Future Work



Weather
Prediction



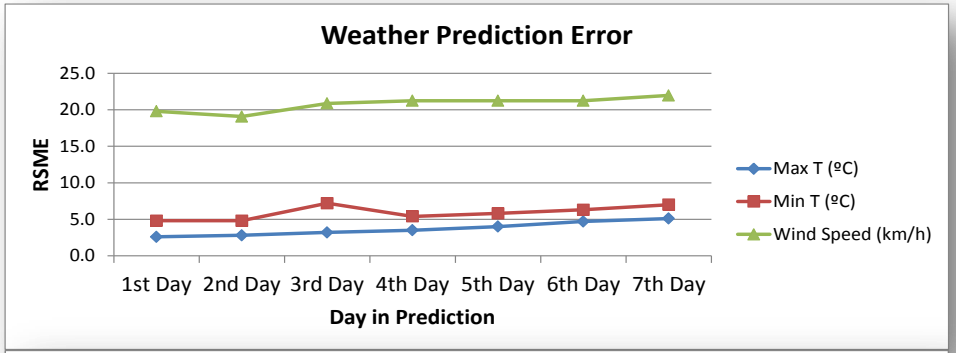
Collision
Prediction

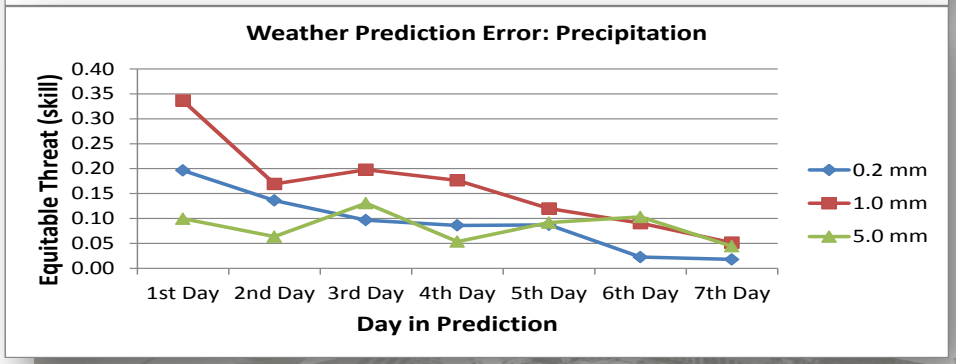
Weather Prediction

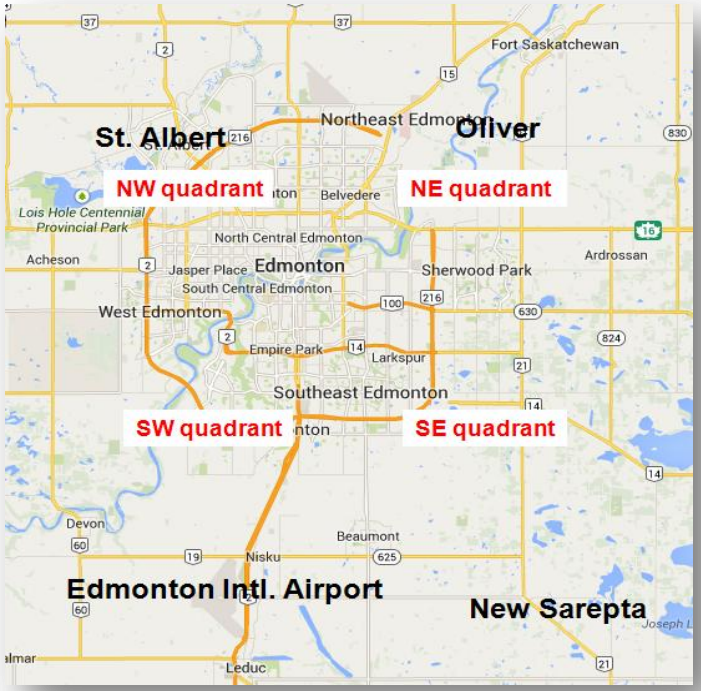
- Predicted variables by four quadrants (NE, SE, NW, SW):
  - Wind speed and direction
  - Barometer pressure
  - Snow and rain fall
  - Air temperature (low, high, mean) and humidity
  - Visibility

- Weather data source: National Oceanic and Atmospheric Administration (NOAA)
- Use Weather Research and Forecasting model (WRF) for prediction
- Prediction accuracy:

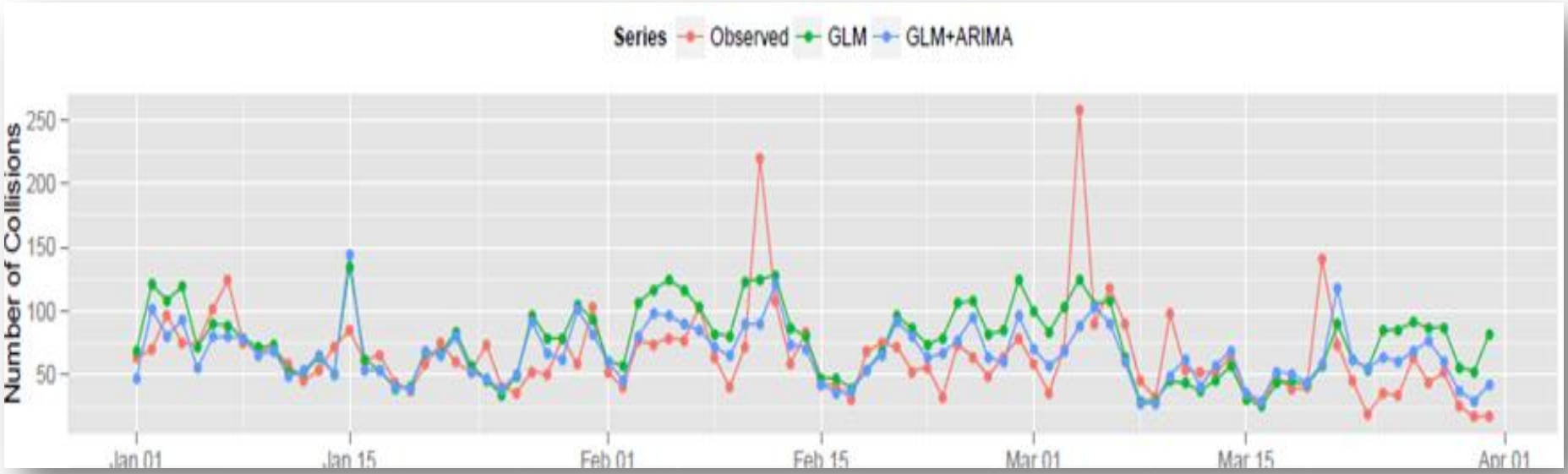
RSME: Root Mean Squared Error







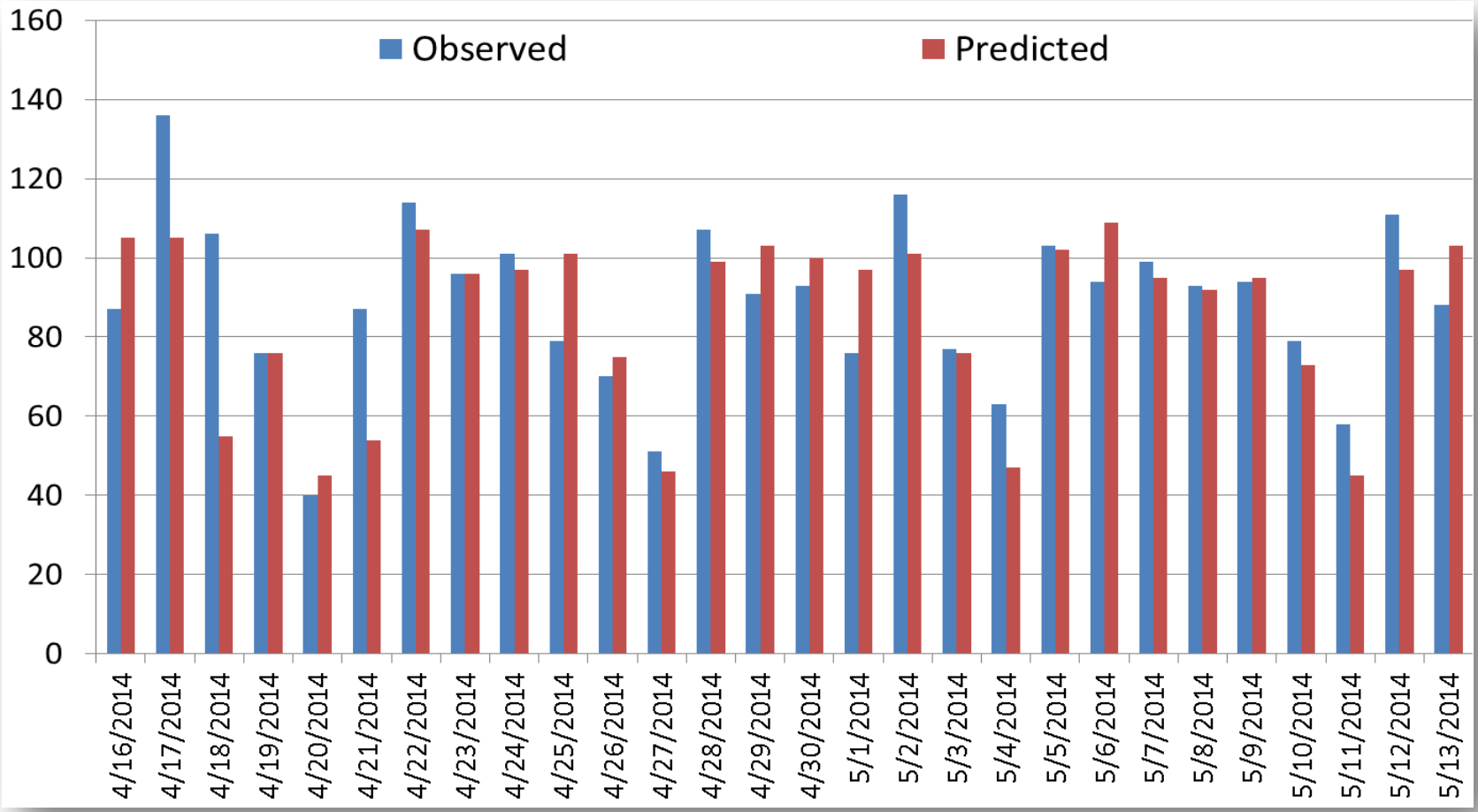
Public Roadway Collision Prediction



Model	MAE	MAPE
GLM	14.21	22%
GLM+ARIMA	12.51	18%
GLM	24.53	45%

MAE: Mean Absolute Error
MAPE: Mean Absolute Percent Error

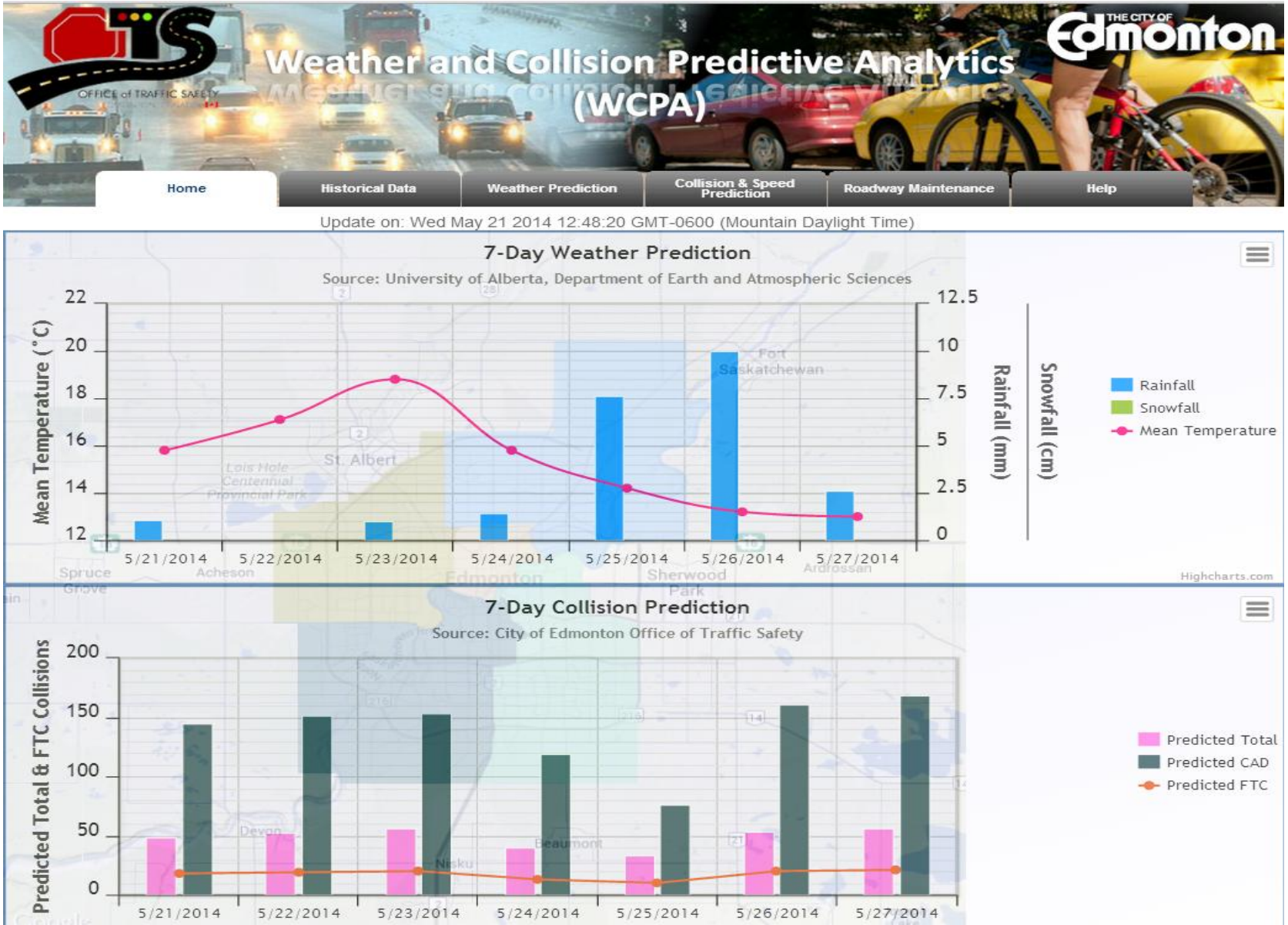
Police call (CAD)-Collision Prediction



MAPE **13%**

Weather and Collision Prediction: Web-Base Application

http://www.its.ualberta.ca/Default



Benefits

Icy Curves Ahead

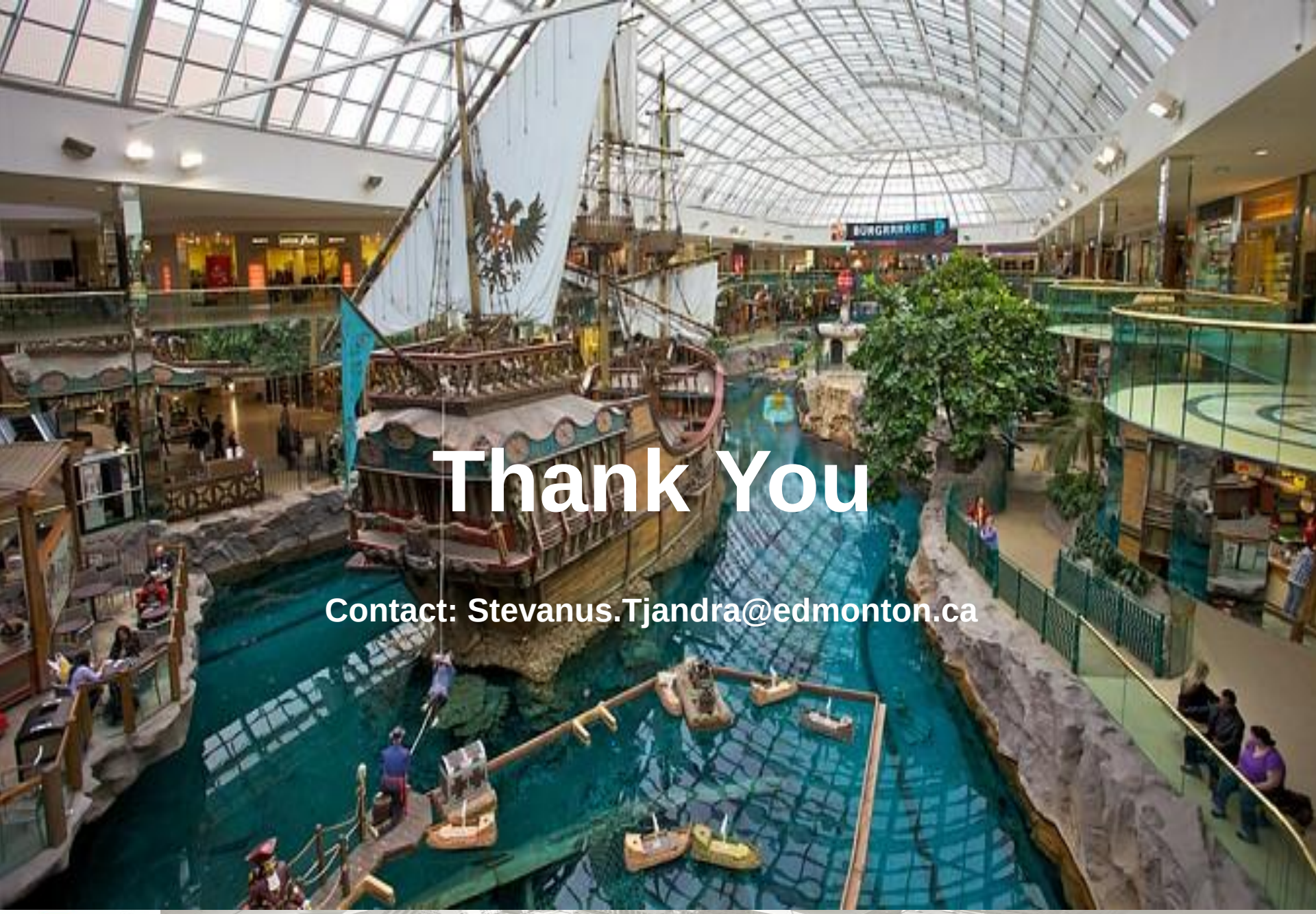
Icy Curve Warning System (ICWS)[1]

- Deployment of the ICWS reduced the number of annual collisions by 18% (CMF = 0.82),
- PDO collision rate was reduced from 5.51 to 4.00 collisions per winter season
- Fatal and Injury collision rate decreased from 2.86 to 2.67 collisions per season
- ICWS has potentially provided safety benefits of $1.7 million dollars per winter season

[1]Zhirui, Y., Veneziano, D., Turnbull, I., "Safety Effects of Icy Curve Warning Systems." Presented at the 91st Annual Meeting of the Transportation Research Board, Paper No. 12-0985, Washington, D.C., (2012)

Next Steps

- Hourly predictions for the next 7 days; models updated every 6 hours
- Alarm threshold development
- Collision prediction by specific area and corridors
- Traffic volume and speed prediction
- CMF and C/B-ratio estimation
- Integration with the Traffic Management Centre
- Utilize media (radio, TV) and social media (Twitter, Facebook) to increase driver awareness



Thank You

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