

# BlueSky Canada: evaluation and recent research

Rosie Howard

& Roland Stull

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Earth, Ocean & Atmospheric  
Science Department

University of British Columbia,  
Vancouver, Canada



# BlueSky Framework (simple version)

Meteorological forecasts e.g.  
WRF model

Wildfire location and fuel  
consumption information

Emissions

Plume rise

**HYSPLIT**  
(**HY**brid **S**ingle-**P**article **L**agrangian **I**ntegrated **T**rajectory)

Output: animations of ground-level  $PM_{2.5}$  concentrations, displayed on web

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Qualitative verification comparing with satellite images

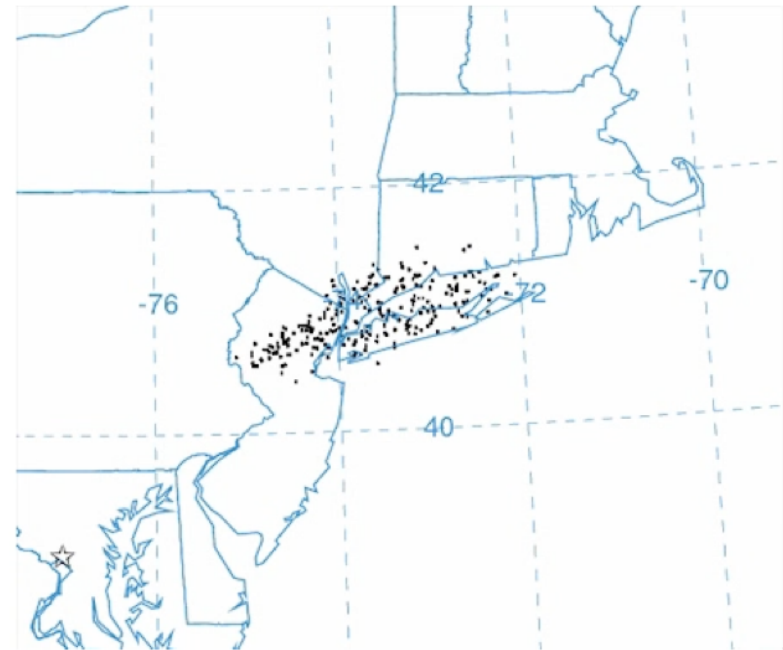
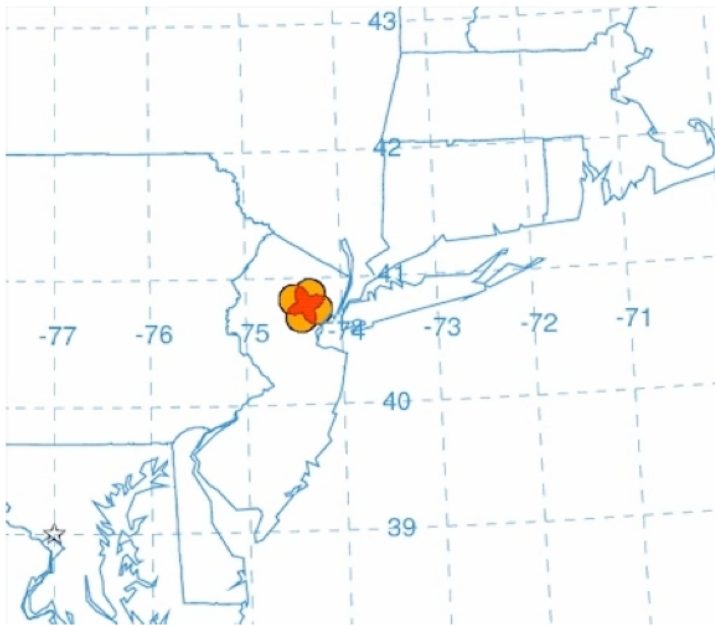
Quantitative verification of downscaled point forecasts

# Qualitative verification

- Current BlueSky operational output shows **ground-level** concentrations of  $PM_{2.5}$
- Not a fair comparison with satellite images
- NEW: added **column-integrated output** – currently shows in KMZ and netCDF files in test cases
- Case study:
  - Northwest Territories: 23 July 2014
  - BlueSky v3.5.1
  - Particle mode (puff mode used operationally)



# Puff vs. particle mode



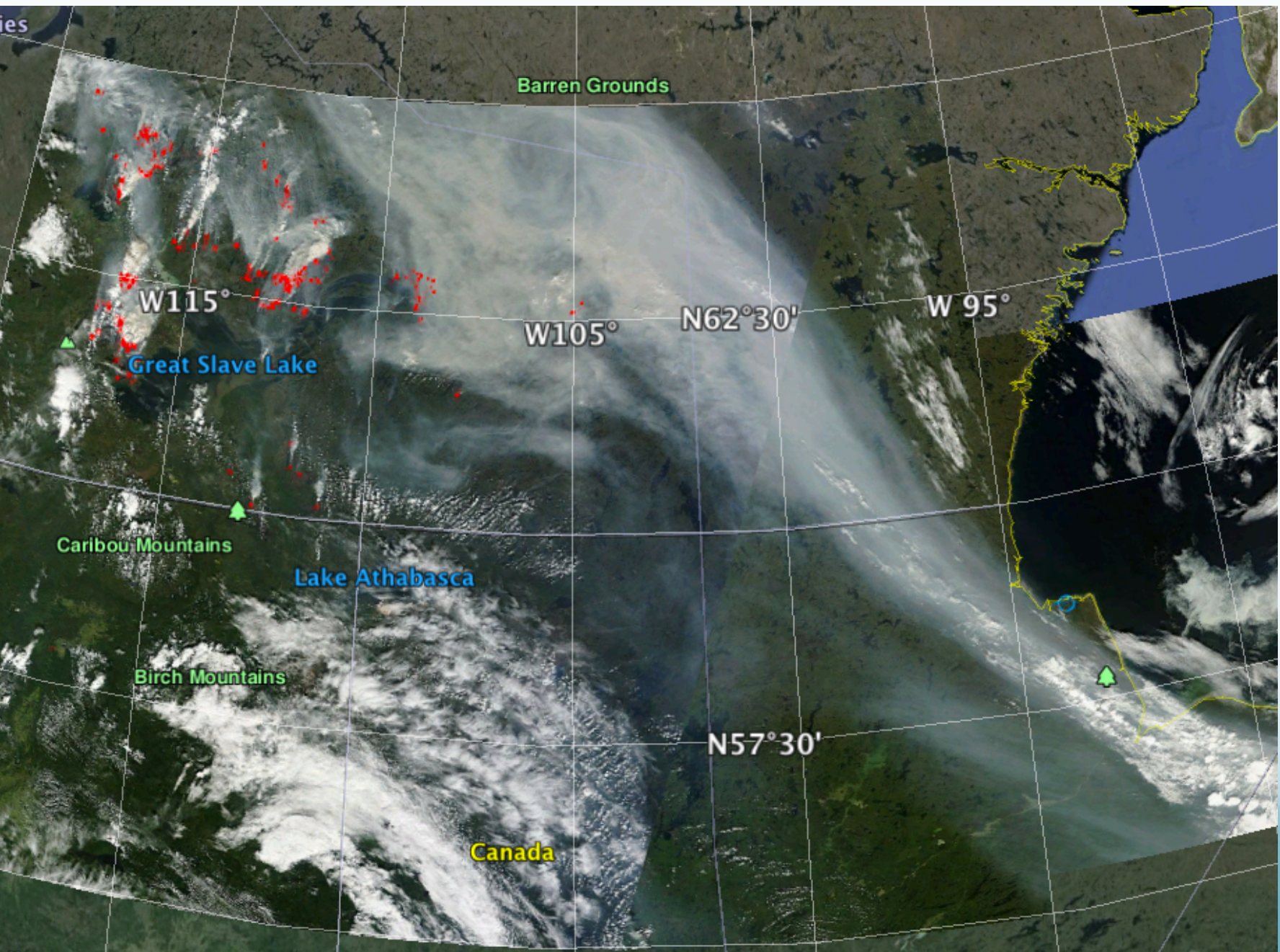
## Puff mode:

Advects with mean wind at centre  
+ size/shape expands with turbulence

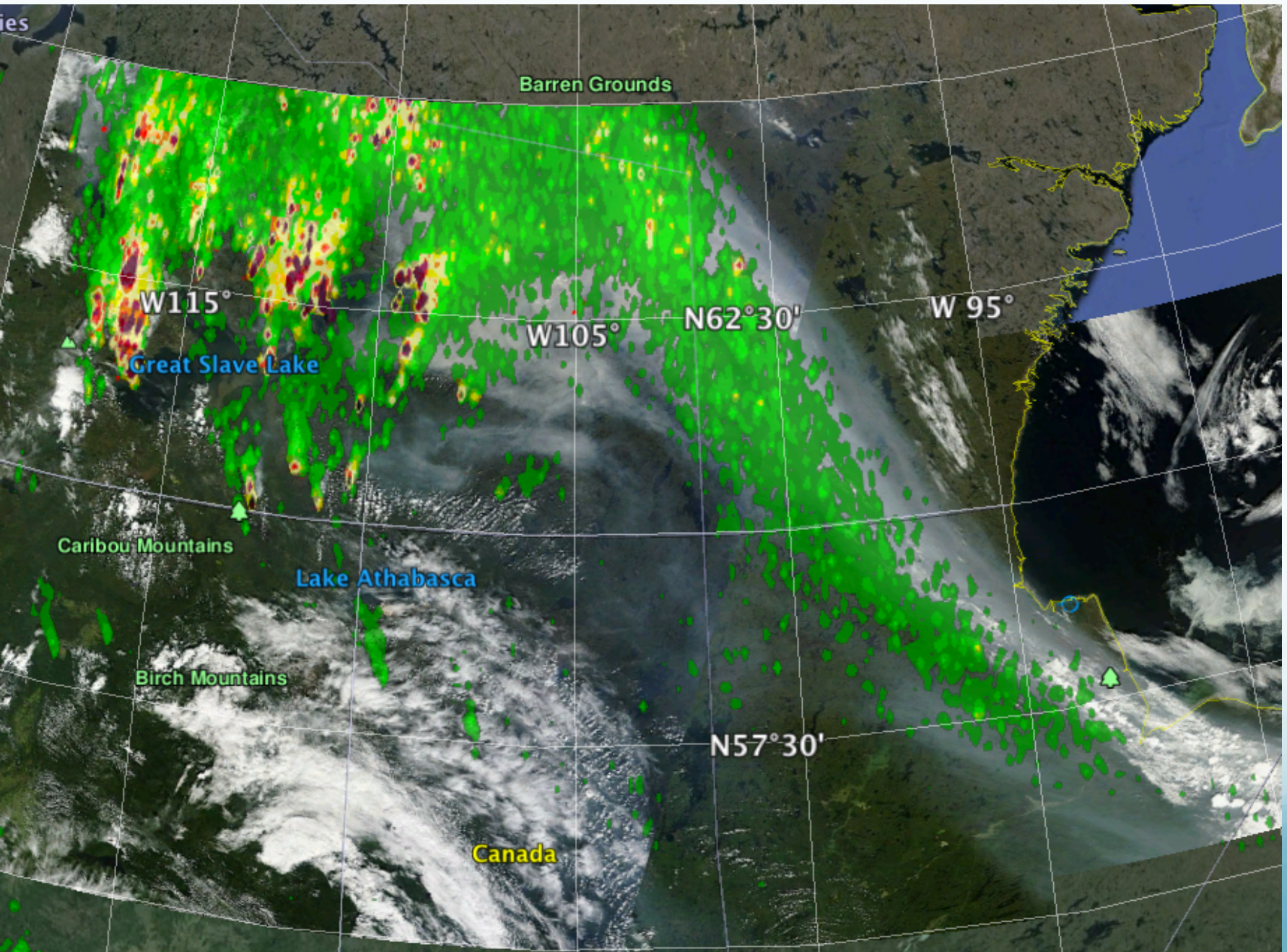
## Particle mode:

Advects with mean wind  
+ random (turbulent) component

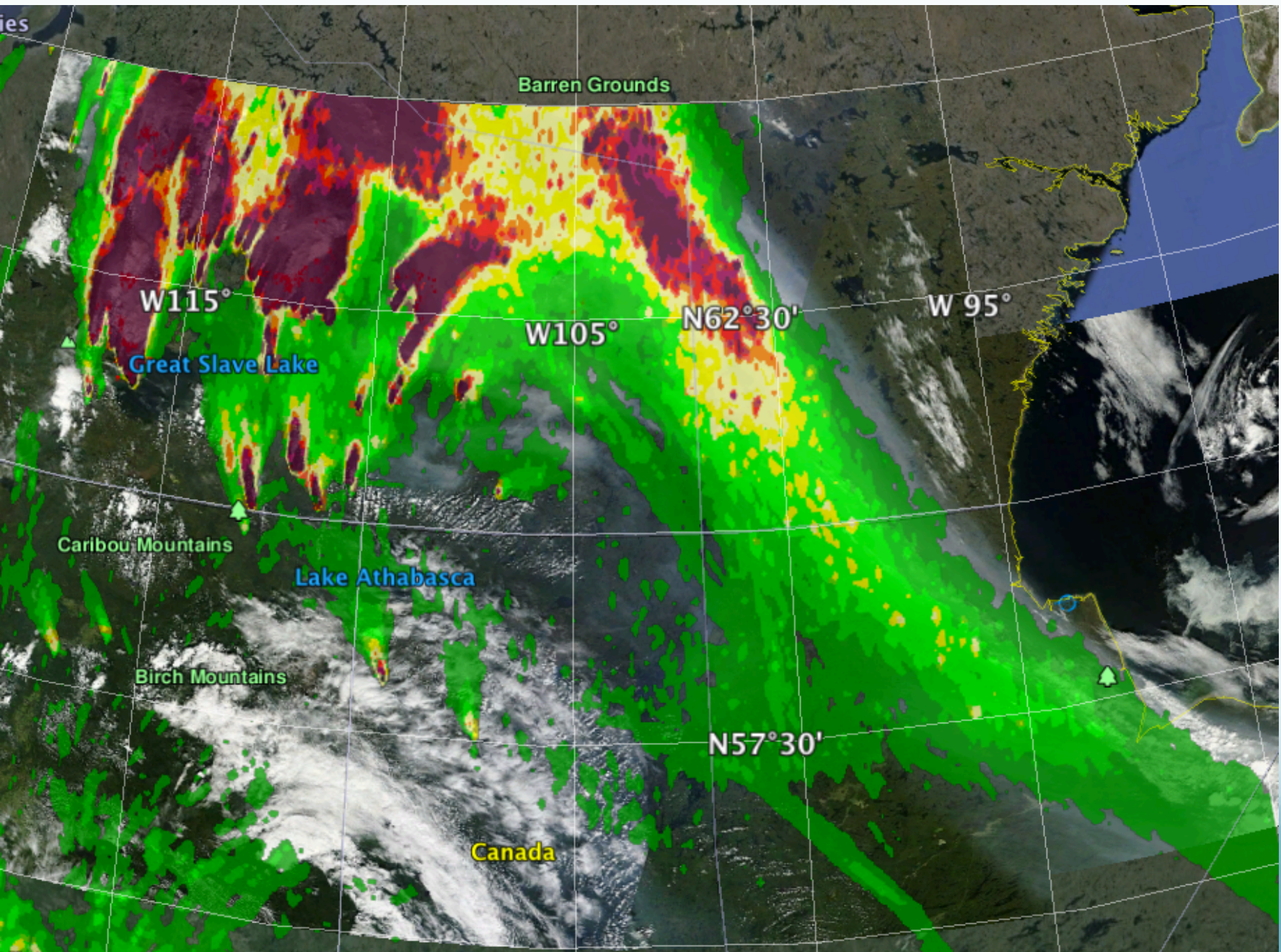
# 23 July 2014: Terra satellite



# 23 July 2014: Terra satellite with BlueSky ground-level output



# 23 July 2014: Terra satellite with BlueSky column-integrated output



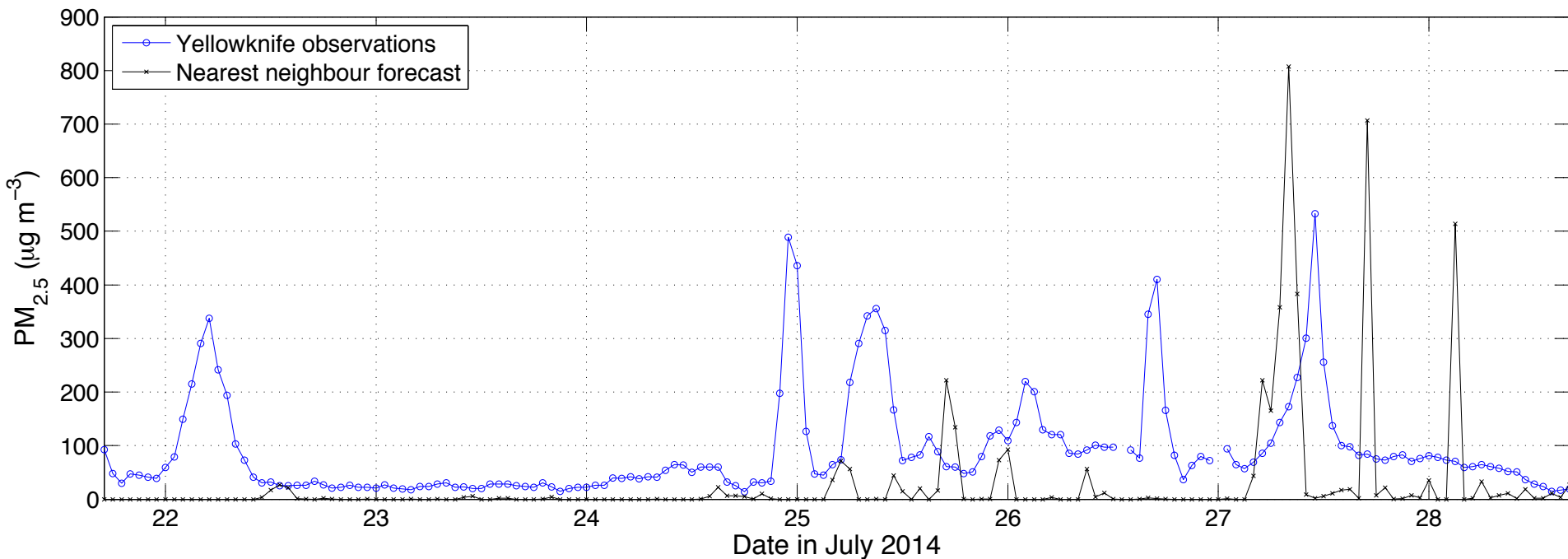


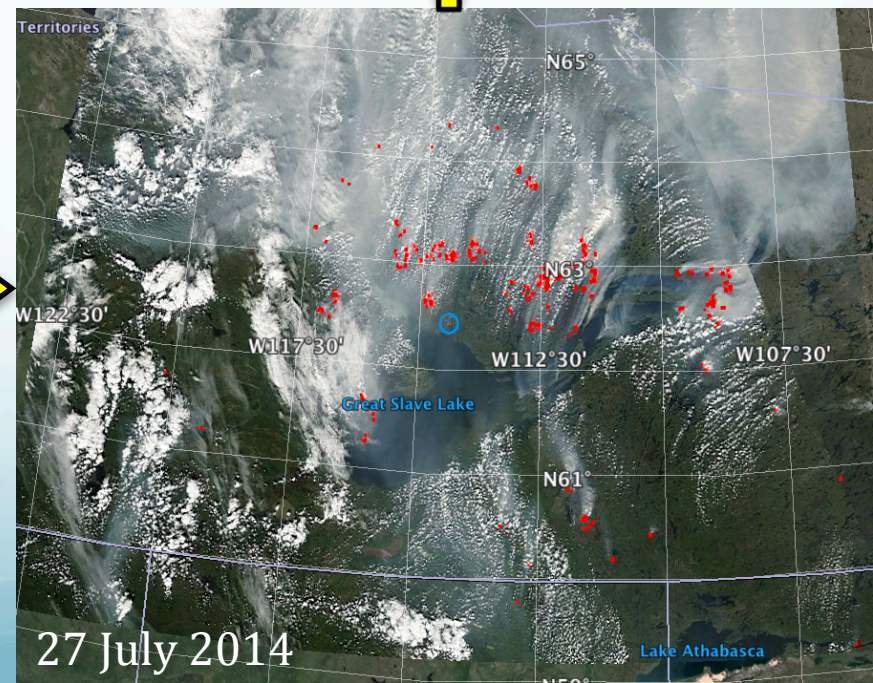
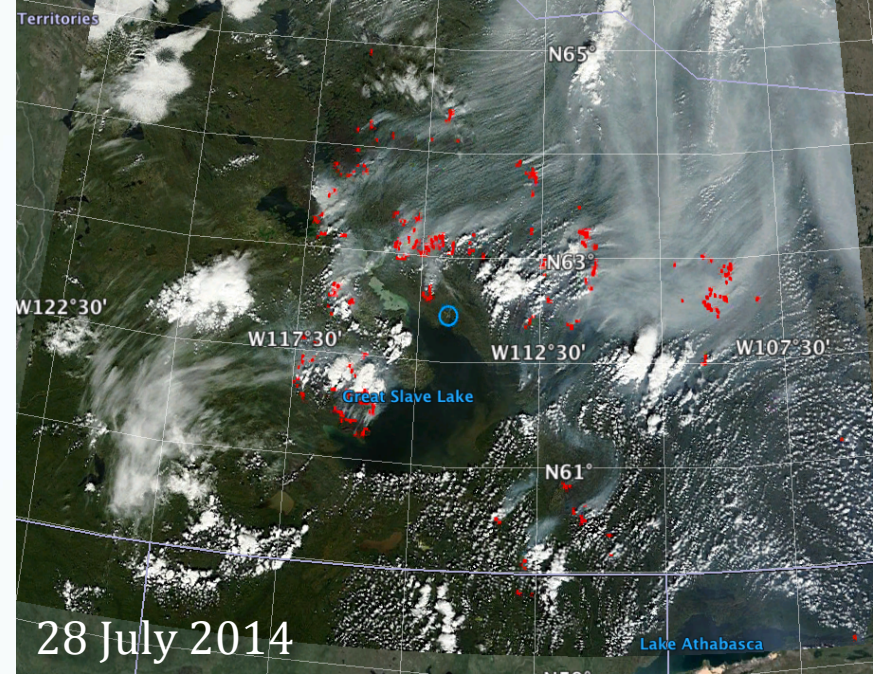
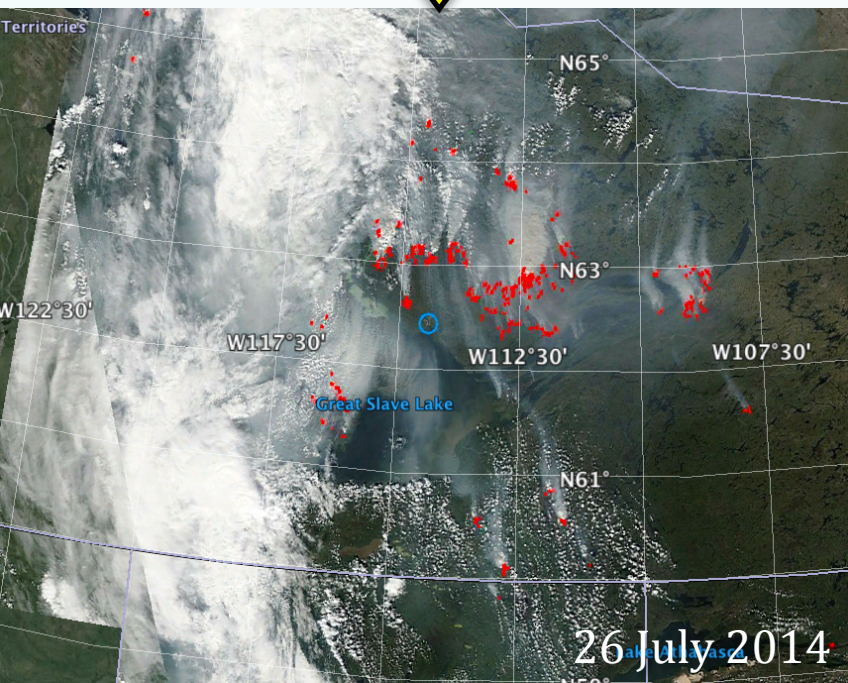
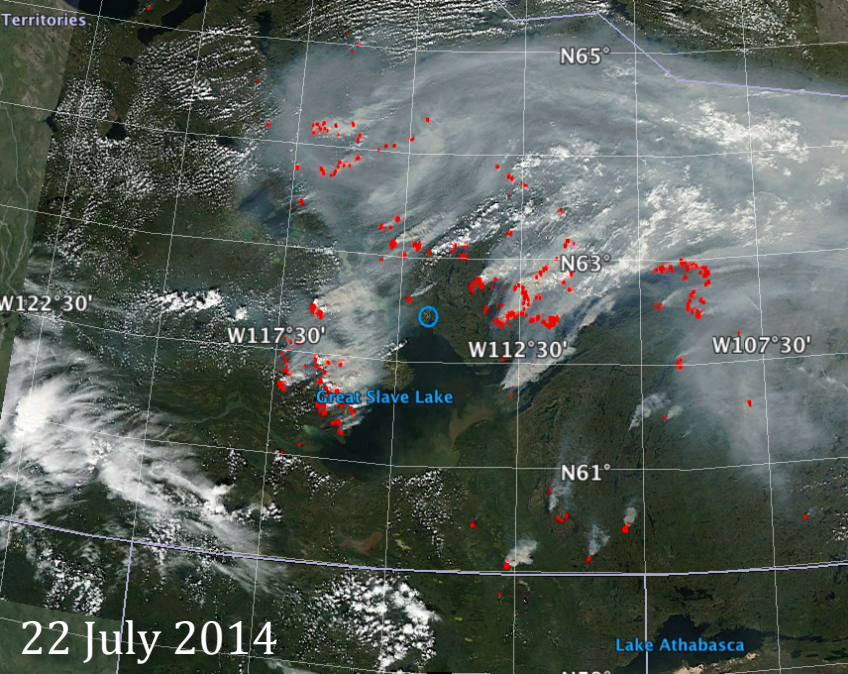
# Quantitative verification

- Comparison of nearest-neighbour point forecasts of  $\text{PM}_{2.5}$  with observations
- Case study:
  - Yellowknife, NWT: 22-28 July 2014
  - 24-hour BlueSky forecasts initialized at 00 UTC
  - Particle mode
  - Carryover smoke

# Observations vs. forecast

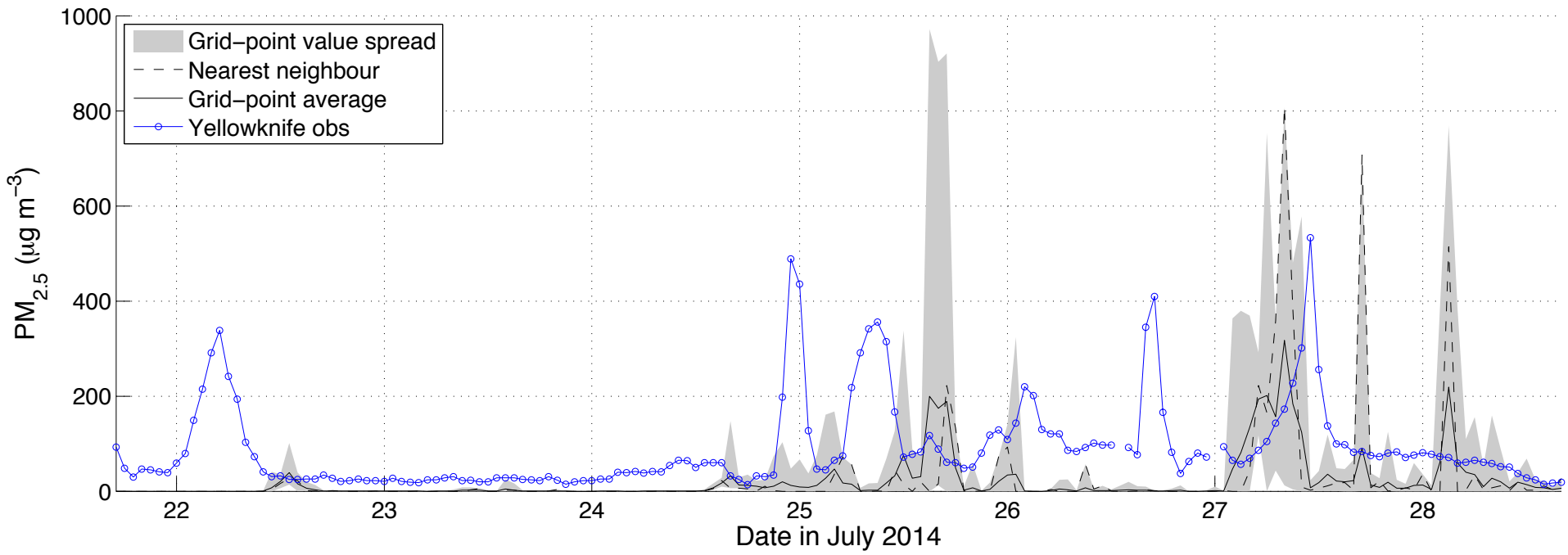
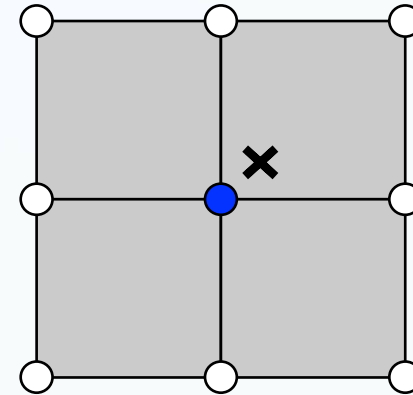
- Forecasts follow general increase in smoke presence
- Timing and magnitude of events
- Why?
- How can we improve?





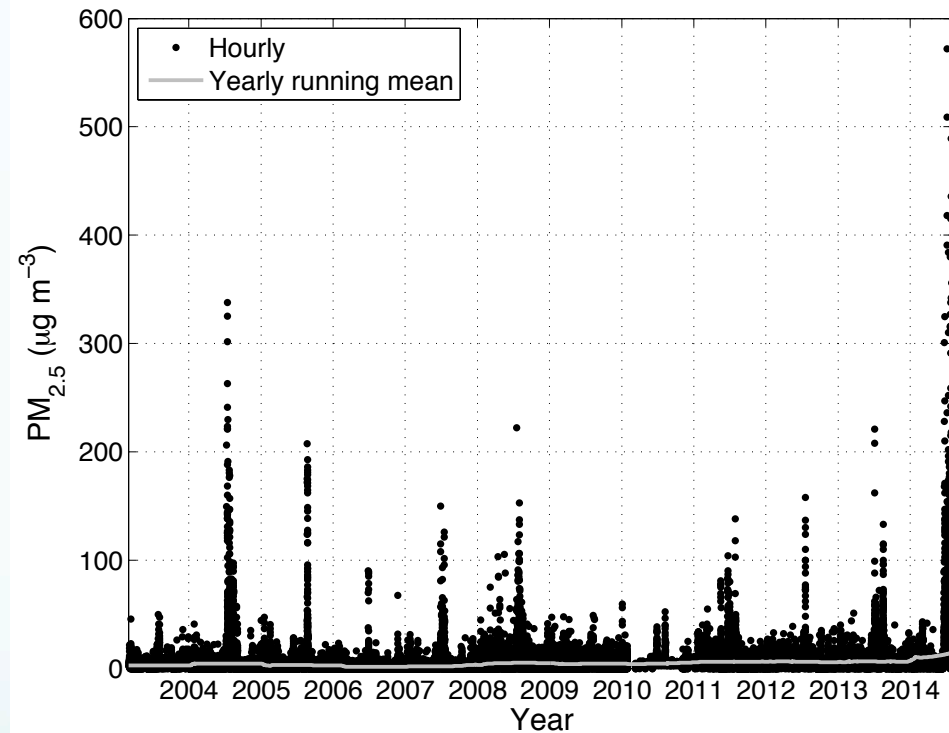
# Improvements

- Output techniques:
  - Nearest neighbour
  - Grid-point average
  - Grid-point value spread



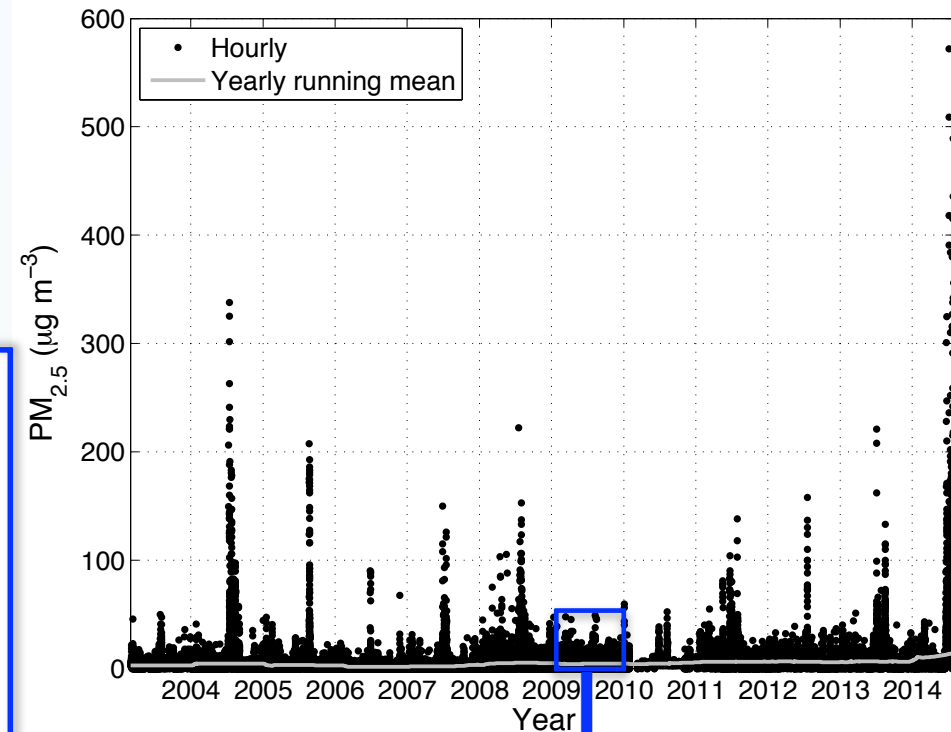
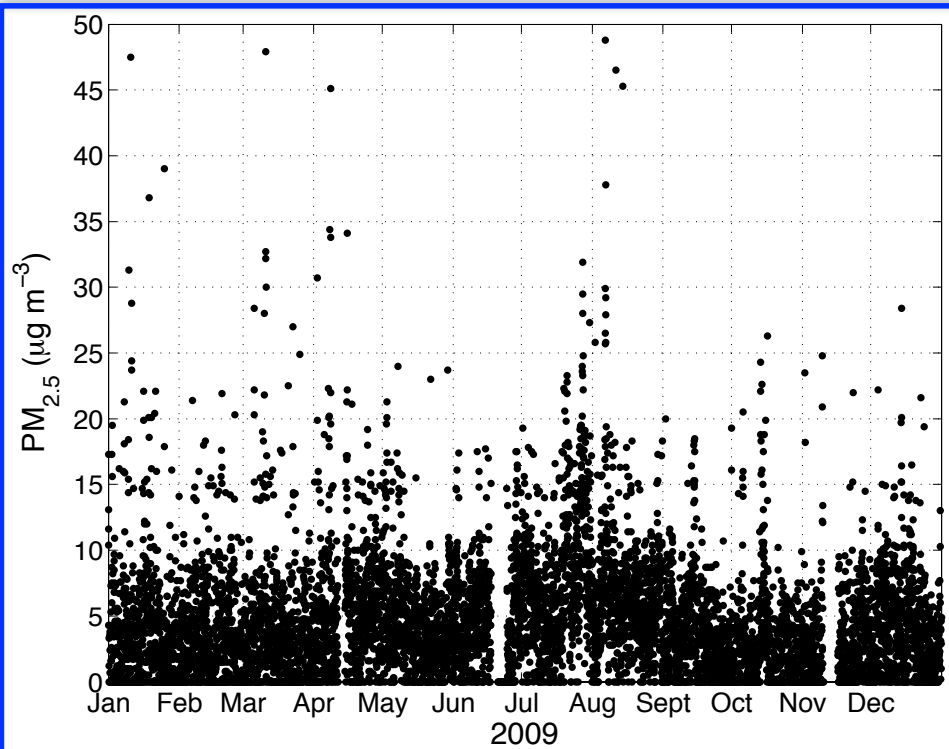
# Improvements

- Add background  $\text{PM}_{2.5}$  to smoke forecast



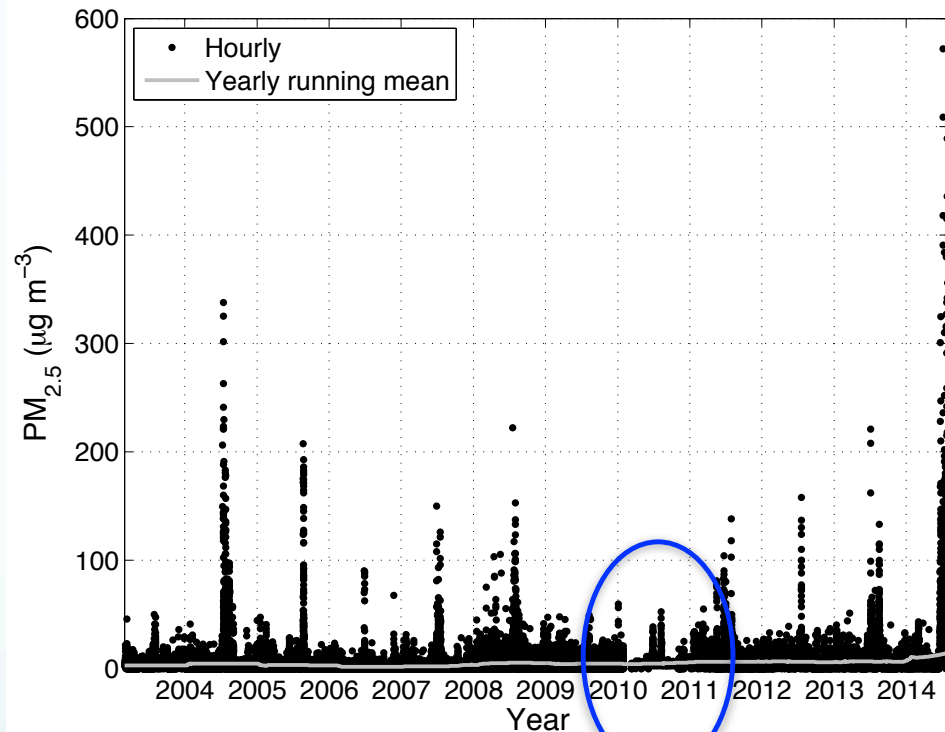
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- Add background  $\text{PM}_{2.5}$  to smoke forecast
- Use summer with “minimal smoke” e.g. 2009



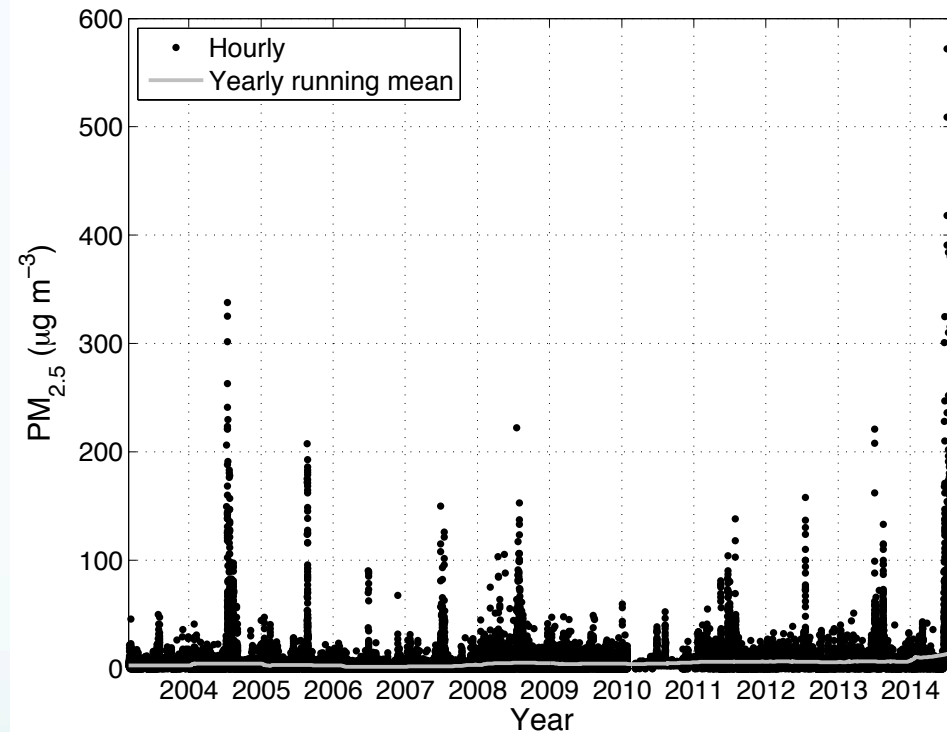
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  - Normalize observation records for different sensors



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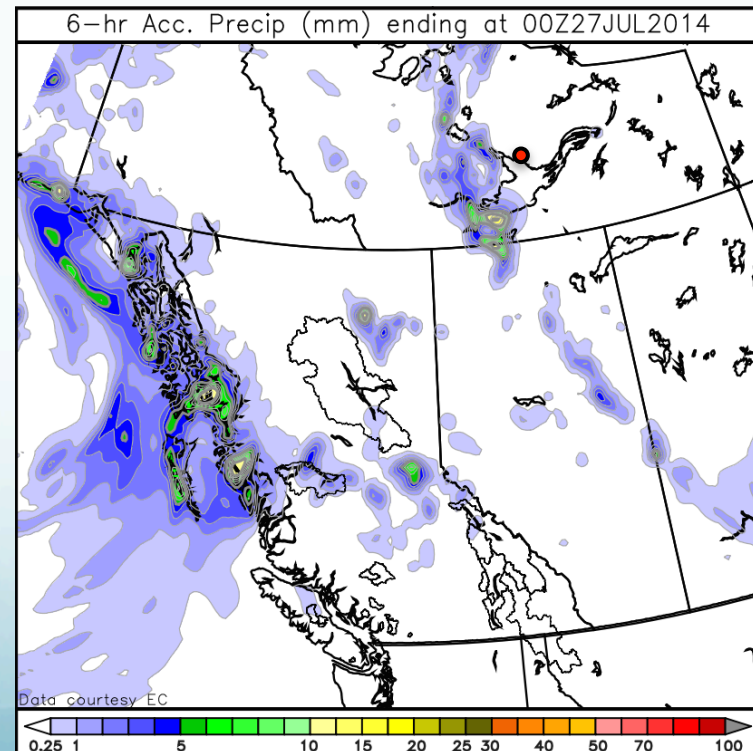
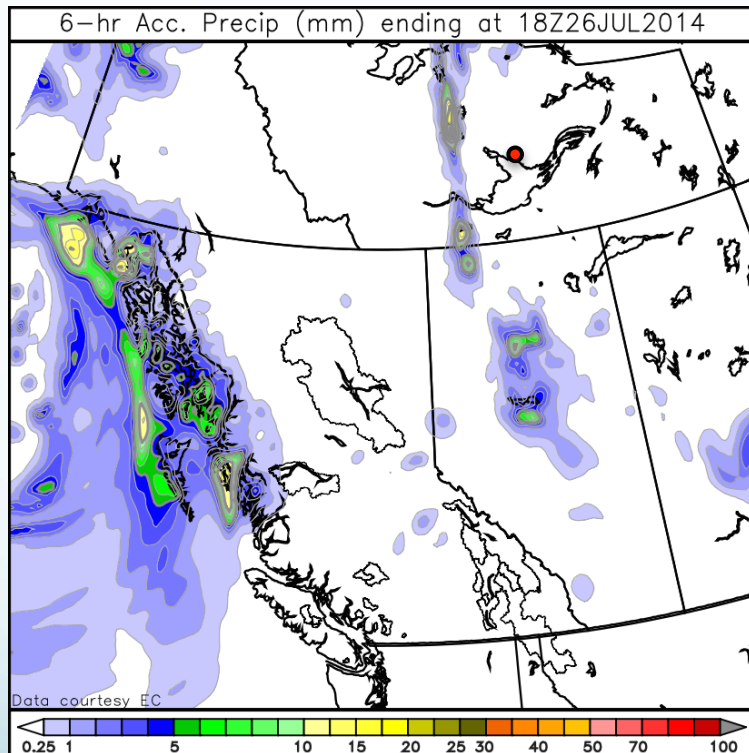
- Add background  $\text{PM}_{2.5}$  to smoke forecast
  - Use summer with “minimal smoke” e.g. 2009
  - Normalize observation records for different sensors
  - Isolate forest fire smoke using ratio of  $\text{PM}_{2.5}$  to other constituents, e.g. carbon monoxide, nitrogen oxides, ozone, etc.





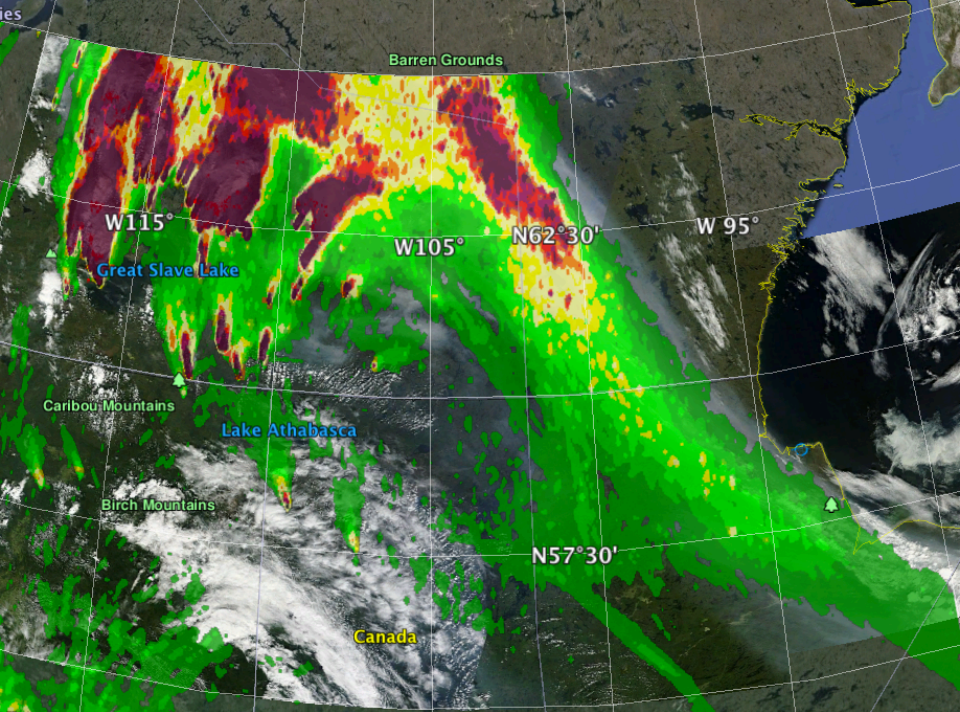
# Improvements

- Model rainout/washout



# Summary and future work

- New column-integrated smoke output for qualitative verification
- Point forecast improvements:
  - Increasing information: nearest neighbour, grid-point average, grid-point value spread
  - Calculating background  $PM_{2.5}$
  - Researching/testing wet deposition parameters for  $PM_{2.5}$
- Different downscaling methods for point forecasts, e.g. cubic spline
- Plume rise model → Kerry Anderson/Roland Stull



Questions?

Rosie Howard (rhoward@eos.ubc.ca)

Weather Forecast Research Team,  
 Dept. of Earth, Ocean and Atmos. Sciences,  
 University of British Columbia,  
 Vancouver, Canada

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Canadian Safety  
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