Road Dust and Implementing NORTRIP in Iceland

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Conditions in Iceland

Quick overview of PM10 in Reykjavik

Air quality would be great if this was the way of travel 😊
Reykjavik over health limit

Eruptions
(Eyjafjallajökull 2010
and Grímsvötn 2011)
Frequency of sources (>50 µg/m³; 24-h)

- Traffic: 39
- Local resuspension: 34
- Dust storms: 22
- Fireworks Remote: 3
- Remote: 2
**PM$_{10}$ levels and range**

- Traffic exceedances generally closer to 50 $\mu$g/m$^3$ (24-h average) than local resuspension events, and dust storms.
**PM Composition**

PM composition examined over the last 15 years in Reykjavík (Höskuldsson, 2013; Höskuldsson & Thorlacius, 2017; Skúladóttir et al., 2003).

- **2003**
  - asphalt: 55%
  - soil: 25%
  - soot: 7%
  - salt: 11%
  - brake lining: 2%
  - ash: 2%

- **2013**
  - asphalt: 30%
  - soil: 31.2%
  - soot: 18%
  - salt: 17%
  - brake lining: 14%
  - ash: 3%

- **Winter 2015**
  - asphalt: 48.8%
  - soil: 7.7%
  - soot: 3.9%
  - salt: 1.6%
  - brake lining: 18%
  - ash: 30%
Contributions from Iceland

• Long time series of PM$_{10}$ (and PM$_{2.5}$), along with, NO$_x$, some other gasses and wind speed and direction, precipitation proxy, and other.

• Where we can look for changes because ...
There are some changes in ... studded tire use

- Changes in PM production with time, given that
  - Studded tire use has decreased
    - From 2/3 to 1/3 to 1/2 in the last 10 - 15 years in the capital region.
There are some changes in ... traffic volume

- Traffic volume has increased

Traffic volume
Reykjavik sum of 3 transects
There are some changes in ... diesel cars

- Fraction of diesel vehicles has increased
  - 1995 5.5% of private cars with diesel engine
  - 2000 10.2%
  - 2005 13.2%
  - 2010 18.4%
  - 2014 23.9%
Want to do measurements

• Quantifying the effects of dust binding and sweeping measures.
  • Analyze measurement series.
  • Collect information about what is done in terms of road maintenance.
    • Plans for tests – long time series make for interesting comparison.
Messy road cleaning

Photo: Ólafur Guðmundsson
Tasks for Iceland

• Improve model of PM near busy roads.
• Compare with (or use) NORTRIP.
  • Note that we don’t have available basic information such as the composition of the car fleet – at least yet.
• PM10 vs PM2.5 – size distribution in the air.
Simple model ...

• Includes
  • Traffic – combined exhaust and non-exhaust
  • Local resuspension – need to define some storage
GRE 2015
Missing

• Snow cover, road moisture, ...
• Better storage term
• Some “strange” peaks from local sources
Model vs measurements

- Does alright, but not great
- Storage, and hence generation and losses, need more work

→ NORTRIP
NORTrip
in Iceland
Martina Stefani (MS)
&
Throstur Thorsteinsson
Implementation of NORTRIP model

- Datasets 2012 and 2016
- Main air quality station GRE (Environmental Agency of Iceland); background stations FHG, KOP, HVAL
- Additional meteorological data (precipitation) from Icelandic Meteorological Office
- Traffic data from the Icelandic Road and Coastal Administration from averaged values (no direct count of vehicles passing, averages over year or months; daily variations from NOx*WS calculation)
- Studded tires count from the City of Reykjavik
- Activities (salting, sanding, ploughing) from the Icelandic Road and Coastal Administration database (not available for 2016).
Roads in the capital
Implementation of NORTTRIP model

• The model was run with the default parameters and no adjustments to Icelandic conditions were made. Improvements to the overall performance of the model could be achieved by adjusting or redefining the used parameters, related to the road wear for example.

• The model does not give a satisfactory correlation between modelled output and measured PM concentrations

(Denby & Sundvor, 2012)
Data needed for NORTRIP

• Car fleet composition
  • Change with time – i.e. diesel cars
  • Rough estimate (Heavy duty vs. light duty, ...)

• Studded tire use
  • Change with time – both numbers and type

• Road cleaning efforts
  • Salt
  • Binding
  • Cleaning

• Road surface types
  • Is thin, soft rock (Icelandic), and sometimes laid out at too low temperature ...
Limitations

- Datasets are incomplete and measurements missing over different periods (if not the main air quality station, the background stations)
- Traffic data based on averages and not on real time traffic counts
- Origin of dust: dust sources on the sidewalks
Data for NORTTRIP

• **Traffic data**
  - Extrapolated from seasonal or monthly averages and therefore do not reflect day to day variations in the hourly traffic passing the investigated road stretch.
  - Vehicle speed, important in generating PM from non-exhaust emissions is only inferred from the existing speed limits.

• **Air quality monitoring data**
  - The closest background station to GRE is FHG, located within a green area around 1.1 km NNE from the test site. It can’t be excluded that this air quality station is affected by the traffic at the test site, and it can be influenced by other sources such as dust from soil and non-vegetated areas within the park. FHG data are very often not available for the investigated time periods.
Winter daily traffic (WDT) average multiplied with NOx*WS variation during days to obtain the hourly traffic variation.
Locations of Air Quality Stations

- **GRE**: main air quality station
- **Background stations**: FHG, KOP, HVAL
Data for NORTRIP

• **No surface moisture**
  - An important parameter which influences greatly the performance of the model for PM concentration.
  - There are no direct measurements available regarding the surface moisture in Iceland for comparison of the road surface moisture sub-model performance.

• **Test location**
  - Cannot be described as street canyon and the investigated road stretch is very open. The location was mainly chosen because of the location of the air quality station and because of the availability of traffic counts along the main road (Miklabraut). The presence of the crossroad (Grensasvegur) is contributing to the openness of the area.
Characteristics of Road Stretch

Miklabraut, direction (E); traffic light, 3 lanes in direction E; one lane to turn left into Grensasvegur, one to turn right into Grensasvegur

GRE-air quality station
Characteristics of Road Stretch

Miklabraut, direction downtown (W); traffic light, 3 lanes + one bus lane in direction W; one lane to turn left into Grensasvegur, one to turn right into Grensasvegur
Results

• During 2012 there were 7 days with PM\textsubscript{10} concentrations of more of 50 mg/m\textsuperscript{3}, while the model calculated 10 days.
Results

March-April 2012 – GRE
Background data FHG - several background data missing
Results

March-April 2012 - GRE
Background data HVALEYRARHOLT

Traffic and activity
Mean ACE = 61891 (m/s)
Mean ACA = 65609 (m/s)
Mean speed (m/min) = 65.5 (m/min)
Number of vessels = 7
Number ofploughing events = 6
Number of cleaning events = 5

Meteorology
Mean Temperature = 4.04 °C
Mean relative humidity = 76.4°
Frequency precipitation = 20.9%
Frequency wind = 14.8%

Concentrations
Mean daily concentration = 10.3 μg/m³
Mean background concentration = 9.6 μg/m³
Mean highest concentration recorded = 15.9 μg/m³

Graphs and data showing PM concentrations over time with various models and observed data.
Results

May-December 2012 - GRE
Background data FHG
Mitigation

The use of the NOTRIP model can help to understand the impact of mitigation strategies which could be realized in Reykjavik to abate the air pollution from particulate matter, deriving especially from road traffic.

Knowing the source of PM is also important when considering the potential health effects.

<table>
<thead>
<tr>
<th>1. FAST ACTING</th>
<th>2. FAIRLY FAST</th>
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<tbody>
<tr>
<td>Dust binding</td>
<td>Propaganda against use of studded tires</td>
</tr>
<tr>
<td>Street and sidewalk cleaning</td>
<td>Information about health risks of particulate matter</td>
</tr>
<tr>
<td>Closures / limitations to traffic</td>
<td>Fee for using studded tires</td>
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</tbody>
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<table>
<thead>
<tr>
<th>3. SLOWER ACTING METHODS</th>
<th>4. LONG TERM GOALS</th>
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</thead>
<tbody>
<tr>
<td>Get rid of old polluting cars</td>
<td>Public transportation</td>
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<tr>
<td>Limit heavy duty traffic</td>
<td>Cycling</td>
</tr>
<tr>
<td><em>Ban old and heavy duty cars in certain areas</em></td>
<td>Walking</td>
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<td>Higher taxes for polluting cars</td>
<td>Longer lasting streets</td>
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<td>Better handling of construction zones</td>
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Thank you
NORDUST (I)

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Field work close to midnight 4 April 2017 in Stockholm