ACCEPTED Project
Impacts of Long and Short Term Exposures
Ozone, Health, Climate

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ACCEPTED

Assessment of changing conditions, environmental policies, time-activities, exposure and disease
The problem

- Near-surface ozone is a highly oxidative pollutant, associated with respiratory, and according to recent evidence, also cardiovascular mortality due to short- and long-term exposure.

- As the result of changes in ozone precursor emissions, climate, population size and susceptibility – health effects of near-surface ozone are expected to be different in the future.
• This analysis aimed to quantify current (2010) and future (2050) ozone effects and assess the sensitivity to different factors and assumptions.

• The assessment of health effects was based on short-term and long-term exposure.
  - Using only short-term exposure as often used, the effects might be underestimated.
Methods – European ozone levels

- European background near-surface ozone concentrations were modelled with MATCH at a grid size 50x50 km.

- Global climate model EC-EARTH was used as input of the regional climate model RCA4, forced by the greenhouse gas emission scenario RCP4.5.

- The current climate as 1991-2000 is compared to the future climate as 2046–2055.

- The current ozone precursors emission in 2005 are compared to 2050.
  - Short-term exposure annual as daily 8-h max concentrations.
  - Long-term exposure as summer average (Apr-Sept) of daily max concentrations.
Methods – population and mortality

• Total and 30+ population 2010 and 2050
  – *European projects INTARESE and HEIMTSA*

• Baseline non-standardized all-cause mortality
  – *WHO’s European Health for All Database*

• CR coefficients for short-term effects (*Gryparis et al., 2004*)
  – 0.031% change in total, 0.113% in respiratory and 0.046% in cardiovascular mortality per 1 μg/m³ change in $O_3$

• CR coefficients for long-term effects (*Jerret et al., 2009; Smith et al., 2009*)
  – 0.57% change in respiratory mortality and 0.12% change in cardiopulmonary mortality per 1 μg/m³ change in $O_3$

• Cut-off levels
  – Main scenario 25 ppb, sensitivity analysis 35 and 10 ppb
Results – current ozone levels

**Long-term exposure**
Mean of ozone daily 1h maximum concentrations (µg/m$^3$), April–September

**Short-term exposure**
Sum Of Means over 25 ppb of ozone daily 8h max concentrations (µg/m$^3$ · d)
### Results – health effects on current ozone levels

<table>
<thead>
<tr>
<th></th>
<th>Long-term</th>
<th></th>
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<th>Short-term</th>
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<tbody>
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<td></td>
<td></td>
<td>Number of premature deaths annually</td>
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<tr>
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</table>
Climate change is expected to increase ozone induced cardiopulmonary mortality in Europe on average by 4.5% (-4.5% decrease in Finland, 13% increase in Belgium and 16% increase in Luxembourg)
Effects of emissions change on ozone induced mortality

Current climate, current emissions

Emissions change is expected to decrease ozone induced cardiopulmonary mortality in Europe on average by 45% (-53.5% decrease in Poland and Slovakia, -15.8 decrease in Cyprus)

Current climate, future emissions
## Effects of population change on ozone induced mortality

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<tr>
<th>Population in 2050 (low/medium/high change scenarios)</th>
<th>Change (%) in number of premature deaths annually</th>
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<td>France</td>
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### Sensitivity analysis – effects of SOMO levels

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<td>Respiratory</td>
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<td>21800</td>
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</table>
Sensitivity analysis – effects of baseline levels

**Cardiovascular mortality**

![Cardiovascular mortality graph](image1)

**Respiratory mortality**

![Respiratory mortality graph](image2)

Legend:
- Iceland
- Norway
- Switzerland
- EU members before 2004
- EU members since 2004
Conclusion

• Exposure to near-surface background ozone in Europe is expected to cause 44,000 premature deaths in Europe annually, from which 26,000 due to short-term exposure (assuming a cut-off at 25 ppb)
  – Thus, studies assuming only short-term effects the health impacts of near-surface ozone might be underestimated

• Among the factors, change in ozone precursors seems to be main factors influencing future ozone levels
  – The effects of climate and populations change might be smaller

• However, the estimates are sensitive to cut-off levels and baseline mortality, and population data
Thank you!