Linkages between climate and air pollution

Climate change and local air quality risks
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Impact of Climate Change on Air Quality at the Regional Scale

- Impact of geophysical climate change alone (e.g. « warming ») excluding future climate policy and any change in air pollutant emissions

  => so-called « climate penalty » that would act in addition to other factors such as
  - Emission changes
  - Intercontinental import of air pollutant

- In general assessed with offline chemistry-transport models
  - Forced by climate fields, or sensitivity experiments (ex: +2deg)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ozone</th>
<th>PM</th>
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</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>++</td>
<td></td>
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<tr>
<td>Regional stagnation</td>
<td>++</td>
<td>++</td>
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<tr>
<td>Wind speed</td>
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<td>Mixing depth</td>
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<tr>
<td>Humidity</td>
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<td>Cloud cover</td>
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<tr>
<td>Precipitation</td>
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</tr>
</tbody>
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Table 1: Dependence of surface air quality on meteorological variables.

Jacob & Winner, AE, 2009
Climate Ozone Penalty

- **Meta-analysis:**
  - Several publications since 2007 confirm the penalty.

- **Magnitude of the penalty**
  - +3ppb locally by 2050 in medium scenario,
  - +2ppb widespread in Europe if global warming reach 4K
  - NB: the average reduction in mean O3 is 2ppb since 10yr with ambitious emission reductions!

- **Remaining uncertainties**
  - How would peak / metrics evolve?
  - Some compensation between:
    - A decrease in global models (water vapor)
    - An increase in regional models


Colette et al., ERL, 2015
Impact of Climate on PM10

- Impact 2C: 4 model ensemble
- Robust decrease over most of Europe
  - precipitation changes
  - warmer temperature
- Increase over Southern Europe:
  - Precipitations
  - landuse / dust

PM10 change under +2C climate
https://www.atlas.impact2c.eu
Main messages:
- increase in average ozone risk
- decrease for PM over most of Europe, except mediterranean (dust)

Remaining knowledge gaps
- Ozone:
  - More quantitative metrics: exceedances, exposure proxies
  - Compensation between hemispheric/regional processes
- PM
  - Impact of dust quite uncertain
  - Episodes / exceedances not documented
- Quantitative comparison with other factors
  - Emission changes
  - Intercontinental transport
Climate change and local air quality risks – health impacts

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Climate change and local air quality risks – health impacts (1/3)

- Air pollution → related climate change impacts
  - SLCFs (EC/BC), SO2, ozone have warming and/or cooling impacts on climate
  - EC/BC vs. PM mass?
  - New evidence on long-term (seasonal) ozone effects?
  - New evidence on SO2?
- Climate change → impacts on air quality
  - Increases in ozone (through increased UV/sunlight and biogenic VOCs)
  - Expected changes in PM mass
Climate change and local air quality risks – health impacts (2/3)

- Frequency of extreme weather events and relationship with health / vulnerability of populations
  - Extreme heat
  - Desert dust episodes
  - Wildfires
  - …
- Adaptation of populations
  - Focus on long-term reduction of air pollution
  - In the meantime, can we recommend interventions to reduce personal exposure to air pollutants (use of protective equipment, use of air filters, behavioural recommendations)?
Climate change and local air quality risks – health impacts (3/3)

• Need to ensure consistent mitigation and adaptation policies for air quality and climate
  • Residential heating (wood)
  • Vehicle emissions (diesel)
  • Others?