CityZen Science Policy Brief:
Ozone

Surface (ground-level) ozone is recognized as:

- a threat to human health
- having a deleterious impact on vegetation
- being an important greenhouse gas

The formation of ozone in urban areas is largely dependent on emissions of nitrogen oxide (NO) and nitrogen dioxide (NO_2), known collectively as NOx, volatile organic compounds (VOCs), and carbon dioxide (CO). These are known as **ozone precursors**.

Atmospheric emissions and concentrations of major ozone precursors have decreased significantly in Europe over the past two decades.

Policy Implications

- Emission reduction measures proved to be efficient for ozone precursors, and should be continued.
- Sustained, long term monitoring of ozone and ozone precursors in urban and rural locations is crucial to understanding the effect of regulations to improve air quality.
- Trends in ozone have been small over the last decade, owing to the complexity of ozone as a pollutant that is formed in the atmosphere rather than directly emitted, which makes it more sensitive to meteorological variability and chemical processes.

The same reductions, as for ozone precursors, have generally not been observed for ozone.

→ Ozone remains a crucial air quality problem, with many areas exceeding guideline values in summer.

Of particular importance in urban areas is the change in primary emissions of NO relative to NO_2. Primary emissions of NO have been reduced at a pace more similar to VOC and CO reductions. However, as a result of increased direct NO_2 emissions due to new control technologies, NO_2 levels have not decreased as much as expected.

While NOx typically contributes to ozone formation, high levels of NO under certain conditions can also act to reduce ozone. The changed NO_2-to-NO ratio can thereby significantly affect ozone concentrations in urban areas where ozone levels that were previously depressed by significant emissions of NO, are actually increased when NO emissions are reduced. This remains an important topic for future emission reduction measures, especially with respect to end of tail pipe controls.

http://cityzen-project.eu

Ozone concentrations did not decline as much as expected based on modelled predictions of 10 years ago.

Despite successful reductions of most anthropogenic ozone precursor emissions, ozone concentrations have not been reduced in parallel. This results from factors such as:

- Changes in the NO-NO_2 emission ratio
- Non-linearities in ozone production
- Meteorological variability
- Variation in natural plant emissions of ozone precursors influenced by temperature and meteorology
- Forest fires
- Increased import of ozone from the stratosphere
- Increases in hemispheric background ozone (e.g., owing to increases in methane)

Furthermore, interannual variability has dominated the trends in ozone over the past decade, exceeding any changes attributable to anthropogenic emission reductions.

Future Climate

- In large parts of the Mediterranean results suggest that increased temperatures owing to climate change will enhance natural emissions of ozone precursors causing increases in tropospheric and ground-level ozone.
- Future emission control measures need to account for the paradigm that future temperature increases resulting from climate change will reduce the impact of current measures controlling ozone levels.
- In large parts of Europe currently anticipated reductions in ozone precursor emissions over the next 20-40 years will be sufficient to compensate for the climate change effects, indicating a likely improvement in ozone air quality by the 2040s.

For further information contact:
Michael Gauss
michael.gauss@met.no

→ CityZen results show that ozone in the troposphere and at ground-level will be influenced by climate change, human actions, and changes in the biosphere during the next few decades. In particular temperature change will affect ozone precursor emissions as well as the rates of formation and deposition of ozone.

SEVENTH FRAMEWORK PROGRAMME

prepared by the University of Leicester