Air quality projections for the 21st century

Climate change and air pollution interlinkages
AQ health impacts in Europe:
- loss in life expectancy ~8.5 months
- 400,000 anticipated death each year
Emission reduction

- NOx and VOC (O3 precursors) reduced by up to 30%
- Primary PM2.5 emissions reduced by 10-20%

The downward trend of the past 10 years in emissions of PM and O3 precursors is not reflected in the observations.

Emissions reduction relative to 2002 for the main pollutants and precursors

Fraction of the urban population exposed to air pollution exceeding WHO air quality guidelines (EEA, 2013)
The drivers of air pollution

- **Emission**
  - Primary pollutants
  - Precursors

- **Chemistry**
  - Gas phase
  - Heterogeneous

- **Microphysics**
  - Particulate matter formation

- **Transport**
  - Mixing
  - Diffusion
  - Long range transport
Climate and Air Quality Modelling

Radiative Forcing

Global Climate (World @ 2.5x1.25°)

European Climate (Eur@0.44°)

Climate Forcers & Air Pollutants

Global Chemistry (World @ 3.75x 1.89°)

European Chemistry (Eur@0.44°)

Integrated Assessment

Air quality projections for the 21st century
Emission Scenarios

Policy storylines
- Higher value added products
- Higher share of services
- Higher growth of non energy intensive industries

Outcome:
- Enhanced energy efficiency, renewable energy policies and climate strategies
- 10% lower fuel consumption in 2030 compared to 2005 despite increase of 35% of GDP/capita

Energy consumption by fuel of the PRIMES-2013 Reference projection, EU-28, TSAP IIASA 2013

Declined into two Air Quality policy variants:
- Current Legislation applied in the future
- Maximum Technically Feasible Reduction
Climate and Air Quality Modelling

Radiative Forcing

Global Climate (World @ 2.5x1.25°)

European Climate (Eur@0.44°)

Climate Forcers & Air Pollutants

Global Chemistry (World @ 3.75x 1.89°)

European Chemistry (Eur@0.44°)

Integrated Assessment

Air quality projections for the 21st century
Annual PM25

SHARP REDUCTION BY 2050, ESPECIALLY IN THE MORE AMBITIOUS SCENARIO

Historical (2010)

Current Legislation 2050

Max. Feasible Reductions 2050

Air quality projections for the 21st century
Drivers of change:
PM$_{2.5}$

EMISSIONS DOMINATE
Limited climate « benefit »

Benefit
Less pollution

Penalty
More pollution

Air quality projections for the 21st century
Surface O3 (summertime daily maxima)

IMPORTANT REDUCTION FOR BOTH SCENARIOS DESPITE PENALTY BROUGHT ABOUT BY CLIMATE ON OZONE

Historical (2010)

Current Legislation 2050

Max. Feasible Reductions 2050

Air quality projections for the 21st century
Drivers of change: Ozone (SOMO35)

- EMISSION AND LONG-RANGE TRANSPORT DOMINATE
- Climate penalty is confirmed

Air quality projections for the 21st century
Ozone changes (summertime daily maxima)

REDUCTION IN THE PEAKS (SOMO35)
INCREASES IN THE BACKGROUND (SOMO10)

Current legislation

Max. reduction

Historical

70µg/m³

Ozone (µg/m³)

↑ background

↓ peaks

Air quality projections for the 20th century
Uncertainty

CHIMERE & REG-CM PROVIDE CONSISTENT RESULTS

Webinar: Air Quality and Climate Change
Country-level air exposure changes

SIGNIFICANT REDUCTIONS IN ALL CASES

- For PM2.5 the Max. Feasible Reduction scenario yields uniform exposure to pollution in Europe

- For ozone peaks, north/south gradients remain
The challenge of the transition

AVOID ZIG-ZAG IN AIR QUALITY AND CLIMATE POLICIES

Desulphurisation
Three Way Catalysts-
Petrol
Particulate Filters-
Diesel

Energy Efficiency
Demand Management
Nuclear
Wind, solar, tidal...
Hybrids, EVs, CCS

Uncontrolled coal and oil fossil fuels in stationary and mobile sources

Increase in ‘uncontrolled’ diesel
Biofuels
Biomass
Buying credits overseas

Air quality projections for the 21st century

M. Williams, T&F, 2014
• Air quality and climate are closely related
  • Mitigation: same sources
  • Adaptation: geophysical feedbacks

• Comprehensive modelling framework:
  • Air & climate, global and regional
  • Latest source of input data (EU Thematic Strategy on Air Pollution)

• Results:
  • A reduction of PM2.5 and O3 levels could be achieved by implementing air quality policies despite climate penalty