Session on tropospheric O$_3$
15$^{th}$ and 16$^{th}$ September 2020

Introduction and major issues, summer O$_3$ pollution episodes in Spain, and O$_3$ and COVID19

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6$^{\text{th}}$ Joint Session of the Steering Body to EMEP and the Working Group on Effects
14-17 September 2020
Session on tropospheric $O_3$

Sub-session on atmospheric pollution of tropospheric $O_3$

- Xavier Querol, EMEP- Sci. Bureau: Introduction and major issues, $O_3$ in if summer acute pollution episodes in Spain, and $O_3$ and COVID19
- Tim Butler HTAP. Hemispheric transport of $O_3$, trends and hemispheric contributions to regional background levels, methane issues
- Augustin Colette, TFMM. Trends of $O_3$ in Europe, local/regional/hemispheric contributions
- David Simpson, on behalf of MSC-W and CCC. VOCs used for $O_3$ modelling and VOCs measured in EMEP. Methods used and regional coverage.

Sub-session on $O_3$ effects

- Dorota Jarosinska, TFH, WHO, Ozone and health effects
- Felicity Hayes, ICP- Vegetation, Effects of $O_3$ crops and vegetation
Session on tropospheric O$_3$

AIMS

Review the state of the knowledge on tropospheric O$_3$ pollution in the perspective of the review the Gothenburg Protocol

• Trends and changes in the last decade
• Modelling capabilities
• VOCs and NOx as precursors
• Evaluation of measured VOCs and those needed for proper modelling
• Potential for O$_3$ abatement strategies
• Effects on health and ecosystems

What are we learning on this issue from the COVID19?
• Need for always specifying when trends, contributions, emissions and abatement policies refer to background O$_3$ and spring-summer O$_3$ pollution episodes
• What modelling and experimental tools are available to differentiate local, regional, hemispheric and stratospheric contributions and implement accurate sensitivity analysis?
• Have enough accurate information on VOC precursors covering regional variability and changes in the last decades?
• Is the EMEP strategy on VOCs measurements fully implemented. Does it cover all VOCs necessary for O$_3$ modelling?
• What scales are required for accurately modelling local contributions and complex meteorology?
• O$_3$ acute episodes decreased in the last decades, but are these decreasing in the last one?
• Idem for the increase of urban O$_3$
• What are the feedbacks of O$_3$ and climate?
• What are the expected impacts of climate warming on both BACKGROUND AND LOCAL/REGIONAL O$_3$ pollution episodes?
• And on other pollutants, such as PM2.5, in urban areas where O$_3$ increases
• What are the major effects of O$_3$

TO WHAT EXTEND CAN BE TROPOSPHERIC O$_3$ COTS-EFFECTLY REDUCED AT BACKGROUND AND PEAK LOCAL/REGIONAL POLLUTION
1. Local/regional/hemispheric contributions during intensive O$_3$ episodes: A general mismatch between modelling & experimental approaches

**O$_3$ 2010–2019 Spain**

93,2 of 8hDM averages

N of daily 8hDM ≥ 120 µg m$^{-3}$

**O$_3$ 2000–2015 Spain**

N of days hourly O$_3$ > 150 µg m$^{-3}$

N of days hourly O$_3$ > 180 µg m$^{-3}$

Updated from Querol X. et al., 2016

Science of the Total Environment

N = 332 (excluding Canary Isd.), sites with >7 years, ≥75% data coverage 2010–2019, and in operation 2018-2019
1. Local/regional/hemispheric contributions during intensive $O_3$ episodes: A general mismatch between modelling & experimental approaches

09-11/07/2019, 8, 14, 20 hLT
Airborne, microlight $O_3$ (PO3M), BC, PM2.5, UFP, meteo

$O_3$ & meteo free-soundings 09-11/07/2019

OVOCs, HVOCs 27/06/2019 to 12/07/2019
1. Local/regional/hemispheric contributions during intensive $O_3$ episodes: A general mismatch between modelling & experimental approaches

Results of the field campaign: Microlight flights (09-11/07/2019)
1. Local/regional/hemispheric contributions during intensive O₃ episodes: A general mismatch between modelling & experimental approaches

**Results of the field campaign: Conceptual model O₃ episodes VdG**

- **Day 1**
  - a: Vertical re-circulation & fumigation
  - b: Formation & transport into GV

- **Day 2**
  - X1: O₃ formation and transport in GV same day
  - X2: O₃ accumulated by vertical re-circulation & fumigation in the day

- **Day 3**
  - Y: O₃ accumulated by vertical re-circulation & fumigation in 2 days

**In ’t Veld et al., 2020**
**STOTEN**
**Submitted**

- **O₃ Sevilla (urban background)**
- **O₃ Doñana (remote, regional background)**
1. Local/regional/hemispheric contributions during intensive $O_3$ episodes: A general mismatch between modelling & experimental approaches

Results of the field campaign: Microlight flights (09-11/07/2019)

- **Plume petrochemical plant**
- **Urban plume**
- **Zone with intensive agricultural burning**

*O$_3$ (ppb)*

- 09/07/2019
- 10/07/2019
- 11/07/2019

*Z*
2. The issue of VOCS

Results of the field campaign: VOCs (27/06/2019 to 12/07/2019)

Cluster 0
- 2-Pentanona
- Acetaldehído
- Butiraldehído
- Formaldehído
- Hexanal
- Hexanona
- Hidroxiacetona
- Metacroleina
- Nonanal
- Pivaldehído
- Ácido pirúvico
- Valeraldehído

Cluster 1
- 1,2,4-Trimetilbenceno
- 1-Hepteno
- 1-Octeno
- 4-Etiltolueno
- Acetona
- Acetofenona
- Benceno
- Camfeno
- Decano
- Dodecano
- Heptanal
- Hexametilciclotrisiloxano
- Indano
- m-Propiltolueno
- Nonano
- Octametilciclotetrasiloxano
- Octanal
- Octano
- o-Címeno
- o-Propiltolueno
- Propilbenceno
- Tribromometano
- Trimetilbenceno isómero_1
- Trimetilbenceno isómero_2
- Undecano

Cluster 2
- 1,2,3-Triclorobenceno
- 1,3,5-Trimetilbenceno
- 2,2-Dimetilbutano
- 2-Butanona
- Benzonitrilo
- Butilacetato
- Heptano
- Hexano
- m,p-Xileno
- o-Tolualdehído
- o-Xileno
- Ácido propanoico
- Estireno
- Tetracloroetileno
- Tolueno

Cluster 3
- a-píreno
- Benzoquinona
- b-píreno
- Dimetiletereno
- Glicolaldehído
- Sabinketona
- Limoneno
- m-Címeno
- Metilciclohexano
- Pinonaldehído
- Tetradecano
- Valerolactona
2. The issue of VOCS

Results of the field campaign: (27/06 to 12/07/2019 VdG, 03 to 17/07/2019, Vic-BCN)

Maximum O₃ Formation Potential by aggregating [concentrations x MIR (Carter, 2009) maximum incremental reactivity]
3. Impact on urban O$_3$ rising on oxidative patterns and secondary PM formation

The issue of the origin of organic carbon in PM: Increasing oxidizing patterns

- Urban O$_3$ levels are increasing in many urban areas of the EU
- Causes:
  - Urban NOx decreased very smoothly, but NO more steeply
  - Saturated areas in NOx and VOCs sensitive
- Net effect: increasing oxidizing capacity of the urban atmosphere: higher PM (nitrate and SOA)

**Madrid city: Modelled 2004-2007 averaged annual increase in %**

Saíz-López A. et al. (2017) Scientific Reports 7, 45956

*OH radical*  
*NO$_3$ radical*
4. COVID19 and $O_3$ in Spain

% $O_3$ 8hDMA REDUCTION

PRE-PANDEMIC: 14/02 TO 15/03; LOCKDOWN: 16/03 TO 30/05, RELAXATION: 31/05 TO 30/06 AND 31/05 TO 31/07

Road traffic reduction

in Barcelona
64% whole lockdown
80% full lockdown
22% relaxation June
17% relaxation JunJul

in Madrid
62% whole lockdown
80% full lockdown
34% relaxation June
19% relaxation JunJul

Querol et al. 2020.
In preparation
4. COVID19 and $O_3$ in Spain

8hDMA $O_3$ change 15th March to 30th April

Observed $O_3$ change

Meteorology-adjusted $O_3$ change

Ordóñez C. et al. (2020) STOTEN, 747, July 2020
2000-2019 Mean O₃ µg/m³
+0.10µg/m³/year \( p > 0.1 \)
+0.55µg/m³/year \( p < 0.001 \)

2010-2019 +0.02µg/m³/year \( p > 0.1 \)
+0.13µg/m³/year \( p > 0.1 \)

2000-2019 Mean Oₓ µg/m³
+0.05µg/m³/year \( p > 0.1 \)
+0.01µg/m³/year \( p > 0.1 \)

2010-2019 -0.08µg/m³/year \( p > 0.1 \)
-0.26µg/m³/year \( p > 0.1 \)

2000-2019 Mean Oₓ µg/m³
+0.49µg/m³/year \( p < 0.001 \)
+0.74µg/m³/year \( p < 0.001 \)

2010-2019 +0.00µg/m³/year \( p > 0.1 \)
+0.48µg/m³/year \( p < 0.1 \)

2000-2019 Mean Oₓ µg/m³
-0.11µg/m³/year \( p < 0.1 \)
-0.21µg/m³/year \( p < 0.001 \)

2010-2019 -0.36µg/m³/year \( p < 0.05 \)
-0.31µg/m³/year \( p < 0.1 \)
2000-2019 Percentile 93.2 8 h µg/m³ O₃

2010-2019 -0.28 µg/m³/year p<0.05
+0.19 µg/m³/year p>0.1
-0.28 µg/m³/year p<0.05
-0.03 µg/m³/year p>0.1

2000-2019 N exceedances 1 h>180 µg/m³ O₃/site/year

-0.04 µg/m³/year p>0.1
-0.09 µg/m³/year p<0.001
-0.01 µg/m³/year p>0.1
-0.03 µg/m³/year p>0.1
-0.13 µg/m³/year p<0.001
-0.02 µg/m³/year p<0.1

2010-2019 -0.04 µg/m³/year p<0.1
+0.03 µg/m³/year p<0.05
-0.04 µg/m³/year p<0.05