MEGACITY OUTFLOWS IN EUROPE
IMPACT OF MEGACITY STRUCTURE
PLUME TRANSPORT & EVOLUTION

Overview of the works conducted at LISA

Isabelle Coll, Guillaume Siour
What is the influence of megacities and megacity structure on regional pollution and continental export?

Light pollution in Europe

Institut des Sciences et Technologies de la pollution lumineuse
How can we characterize the chemical evolution of pollutants in megacity outflows?

Ozone simulation with CHIMERE
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Redistribution of landuse

Intensification vs city spreading

Influence of megacity shape on megacity pollutant production

Impact on ozone production

Area of impact of megacities

Export pathways

Plume temporal evolution
From megacities to all urban: Modelled impact on O$_3$ production and O$_3$ maxima
From megapoles to all urban: Modelled impact on O₃ production and O₃ maxima
From megapoles to all urban: Modelled impact on O$_3$ production and O$_3$ maxima.
From megapoles to all urban: Modelled impact on \( \text{O}_3 \) production and \( \text{O}_3 \) maxima
From megapoles to all urban: Modelled impact on $O_3$ production and $O_3$ maxima

08/08/2003 – Heat wave extreme situation

Grouping city emissions:
- Increase of highest values
- Decrease of low values
- More ozone titration inside cities
From megapoles to all urban: Modelled impact on O₃ production and O₃ maxima

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Grouping city emissions:
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08/08/2003 – Heat wave extreme situation

Original

M-Only

All urban

Same plume structure
Plumes less intense
TRACER EMISSIONS

=> ROLE OF LOCATION IN EUROPE?

SAME AND CONSTANT EMISSION PER CELL
LIFETIMES OF 1 OR 10 DAYS (work of M. Lawrence et al.)
Reference year - situation on 23/06/2005

$O_3$ maxima
From megapoles to all urban: Modelled impact on $O_3$ production and $O_3$ maxima

**Reference year - situation**

$O_3$ maxima / $O_3$ maxima ref
From megapoles to all urban: Modelled impact on $O_3$ production and $O_3$ maxima

Different geographical evolutions for ozone concentration

more O3 downwind the cities in M-only scenario

more background ozone in the All urban scenario

Reference year - situation
$O_3$ maxima / $O_3$ maxima ref
From megapoles to all urban: Modelled impact on $O_3$ production and $O_3$ maxima

Different geographical evolutions for ozone concentration

more $O_3$ downwind the cities in M-only scenario

more background ozone in the All urban scenario

However, chemical regime gradients remain the same
Intensification vs city spreading: towards more realistic scenarios

Reference

City densification

City spreading

Difference in NO$_2$ emissions with reference case
Intensification vs city spreading: towards more realistic scenarios

Increased number of exceedance days in both scenarios

Changes in the location of the exceedances
Intensification vs city spreading: towards more realistic scenarios
Intensification vs city spreading: impact on max $O_3$

$$
\text{max} \left( \frac{[O_3(t)]_{sce}}{[O_3(t)]_{ref}} \right)
$$

Decrease of values at the North

Increase of values at the South

Change in the ozone plume shape and width

Change in the location of the maximum

City evolution may also affect primary pollutants transport pathways (and aerosols)
Intensification vs city spreading: changing export pathways

Export from the Benelux area (reduced period)
Intensification vs city spreading: changing export pathways

Mean summer changes for the 4 megacities and areas

City evolution indeed affects megacity export to the larger scale
Megacity plumes: oxidant production / impact of city shape

Implementation of the SAPRC07 chemical scheme in CHIMERE

Flux calculation at all cell boundaries

Development of a complete chemical tracer approach
PARIS

1\textsuperscript{ary} or 2\textsuperscript{ndary}?
BENELUX
CHEMICAL TRACER APPROACH

Quantify the **part of each VOC in ozone production** without perturbing the system

identify the location where every VOC is **oxidated** and where its products are **transported**

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I. Coll, Air Pollution Conference (2006)
I. Coll, INTERREG (2008)
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**O3 produced by each family**

- **Role of CO**
- +25 ppb
- +15 ppb
Role of boundary conditions (primary species)

O3 produced by each family

- +25 ppb
- +20 ppb

Role of CO

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The influence of **megacity structure** on regional pollution is a critical parameter for pollutant transport pathways and local to regional ozone management.

Role of location in Europe is also critical

It does not appear critical for total ozone export.
As expected, chemical outflows are very sensitive to the extent of urban areas (NOx supply).

Tracers are a very promising method for:

- Identify the species most participating in O3 production at various scales
- Identify the distance of impact of primary pollutants

Ozone simulation with CHIMERE
Megacity plumes: oxidant production / impact of city shape
11H

Participation à O3 (ppbv)

O3 total simulé (ppbv)

AXE DU TRANSECT AU SOL