CO2-MEGAPARIS
Quantification des émissions de CO2 de la mégapole parisienne
ANR blanc 2009-2013

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Plan

• Contexte et stratégie
• Le mini-réseau de suivi du CO2 parisien
• Effet de l’îlot de chaleur urbain sur la dilution des émissions de CO2 dans l’atmosphère
• Le dôme de CO2 urbain et l’effet du vent
• Premiers pas de modélisation
• Conclusions et perspectives
75% of global CO2 emissions come from about 100 urbanized or industrialized areas - In the first line: MEGACITIES -

Quantifying CO2 emissions of biggest cities and power plants can be easier than measuring everywhere over the globe
Why studying CO$_2$ emissions from Paris?

- Paris is the 3$^{rd}$ European megacity (and ~20$^{th}$ at the global scale)
- The region Ile-de-France emits ~15% of CO$_2$ emissions from France for 2% of the territory (source: inventories of AIRPARIF & CITEPA)
- No independent verification of inventories and uncertainties unknown
Synergy between observations and modeling

CO₂ flux calculation by observational methods
- boundary layer budget
- Radon 222/CO₂ correlations – CO, ¹⁴C, K... correlations with CO₂

Synergy:
- intercomparisons of all results and inventories for CO₂ emissions and CO₂/CO ratios
- error estimates
- conference of societal research
- communication to local authorities

Mesoscale network (CO₂, CO, boundary layer height, Radon 222, CO₂ flux)

Intensive campaigns (¹⁴C, ¹³C, ¹²C, O18, O16, CO₂ biospheric fluxes, co-MEGAPOLI, PBL height/CO₂)

CO₂ flux calculation by inverse modeling at high-resolution
- HR inventories
- AROME/Meso-NH + TEB
- LPDM
- ECMWF/CHIMERE

Association of CO₂-MEGAPARIS and CARBOCOUNT

LSCE
LMD
INRA
AIRPARIF
EDGAR
CITEPA
LSCE
LMD
INRA
AIRPARIF
IER
All and
REEDS

I. Xueref-Remy CO₂-MEGAPARIS FAO 25 October 2011
The observation network

- CO2 & CO (red: CO2-MEGAPARIS, orange: RAMCES-ICOS)
- ABL height

Mobile observations with two cars (LIDAR and CO2) along the stations GIF-EIF-GON-QUALAIR-SIRTA
• Montgé-en-Goële
Station de fond rural Nord-Est
Gonesse station: station péri-urbaine NE

Mât 15 mètres
Eiffel tower (6th floor)
GIF: station péri-urbaine Sud-Ouest
Traînou : station de fond rurale Sud-Ouest
Paris urban heat island effect: Impact on the dilution factor of CO2 emissions
CO2 concentration from the 5 stations of the network:

A case study on 21-24 March 2011
The case of the top of the Eiffel tower
Effect of the urban heat island on the dilution of CO2 emissions

CO2 concentration at all 5 stations (21–24 March 2011)

Urban dome / Day
Vs peri-urban: 10-20%
Vs rural: 15-40%

Urban dome /Night
Vs peri-urban: 20-30%
Vs rural: >40%

Day in March 2011
Generally no urban dome or incomplete
Strong underestimation of the ABL height at night (~60%)
How well do models reproduce the ABL height gradient of Paris megapole?

ABL height from Meso-NH 21-24 March 2011

OBSERVATIONS vs MESO-NH with CNRM TEB module
Paris CO2 urban dome
Wind study
At the Eiffel tower station, we observe a flushing of the nocturnal layer during the ABL development.
EIF vs GON
Wind direction and speed

Timeseries of CO₂ gradient EIF minus GON at 14h by wind direction and speed

Date

Paris mean CO₂ plume in mid-afternoon
EIF vs GIF
Wind direction and speed

Timeseries of CO₂ gradient EIF minus GIF at 14h by wind direction and speed

Date

Paris mean CO₂ plume in mid-afternoon
Averaged gradient per wind sector

Northern sector

GON to EIF
$\Delta CO_2 = 3.5$ ppm

Southern sector

EIF to GON
$\Delta CO_2 = 2.1$ ppm
Modeling
Direct modeling (CNRM)

Physiographic data from ECOCLIMAP (1km resolution)

Anthropogenic CO2 emissions from Stuttgart (10km resolution)

CO2 concentration initialized the first day and coupled with an homogeneous vertical profile (~400ppm). The other days, CO2 cycling
March campaign: Meteorology

Measurements

Meso-NH

Trappes soundings

Midday

Midnight

- Good PBL height except the 21
- Slight underestimation of the near surface temperature

- Good representation of the inversion
- Slight overestimation of the near surface temperature

Colloque Changements Environnementaux - 21 et 22 mai 2012
Inverse modeling (LSCE)

Flux prior/corrigés

22/09/2010 à 12:00 UTC

ECMWF/CHIMERE

Colloque Changements Environnementaux - 21 et 22 mai 2012
Acquis:
• Urban canopy model seems mandatory for modeling CO2 urban emissions
• Strong daily variability of Paris CO2 urban dome
  (0 to more than 20 ppm, windspeed dependent)
  ⇒ Importance of good meteorological monitoring (winds & hABL)

En cours:
• Stations footprint, CO/CO2/NOx study, mass budget method and modeling
• Publications: 1 submitted & 7 in preparation (project delayed of 1 year)

Perspectives:
• Future projects:
  - CO2-Megaparis-II (submitted): continue atmospheric measurements to assess trends in emissions & deep inventories study (phD student)
  - MEGACITIES: collaboration with Los Angeles and local stakeholders to densify urban networks (30 k€ from Mairie de Paris to run a network design study)
  - Development of a collaboration with LNE for calibration gases supply