CO2-MEGAPARIS

Quantification des émissions de CO2 de la mégapole parisienne

ANR blanc 2009-2013

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Partenaires: LMD – Fabien Gibert

CNRM – Christine Lac

INRA – Pierre Cellier

REEDS- Jean-Paul Van derlinden

Sous-traitants: AIRPARIF, CITEPA

Guests: IER Stuttgart, LATMOS (François Ravetta)

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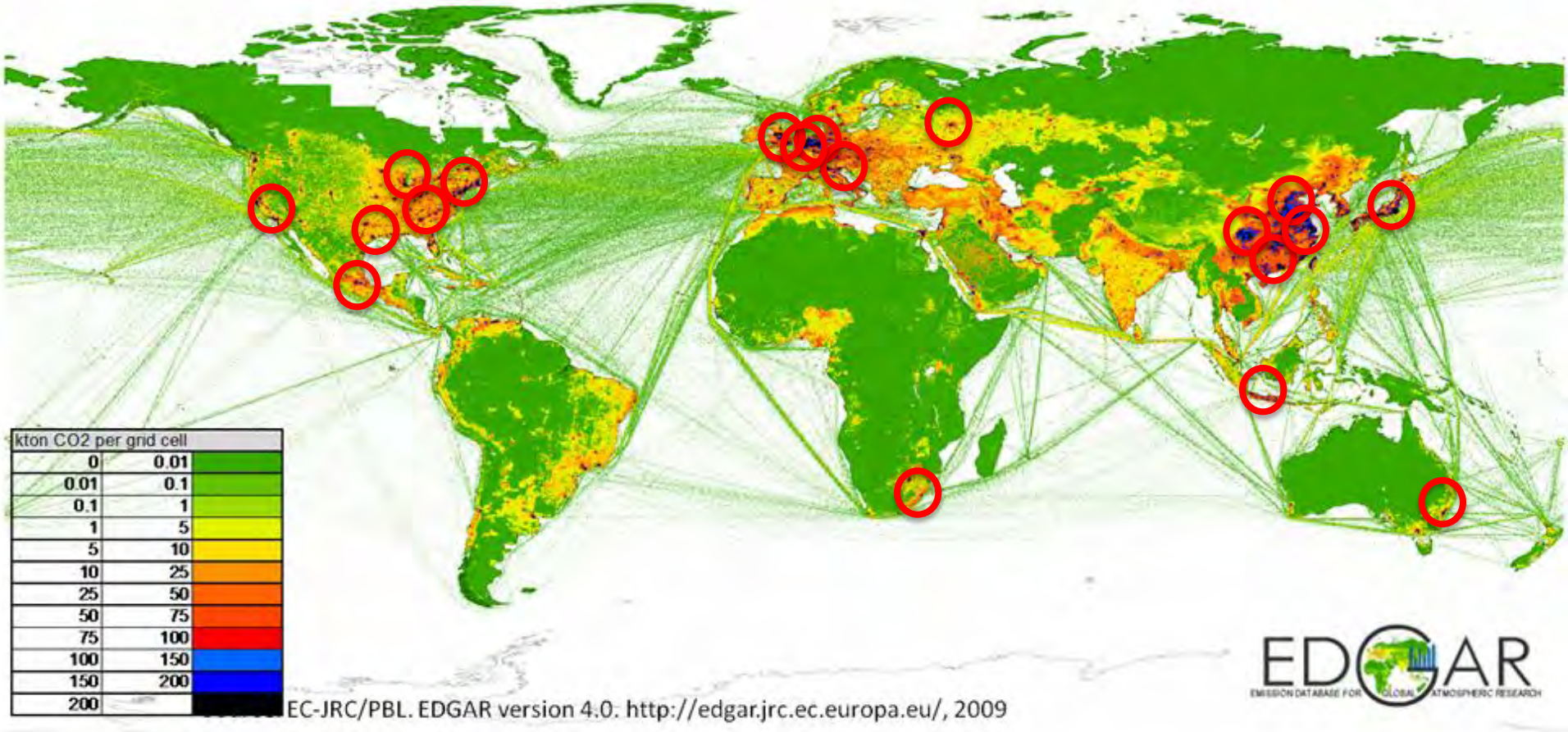
http://co2-megaparis.lsce.ipsl.fr

Plan

- Contexte et stratégie
- Le mini-réseau de suivi du CO2 parisien
- Effet de l'ilôt 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

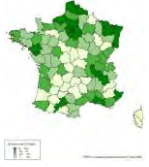
75% of global CO2 emissions come from about 100 urbanized or industrialized areas - In the first line: MEGACITIES -



Quantifying CO2 emissions of biggest cities and power plants can be easier than measuring everywhere over the globe

45MtCO2/an

12000km²

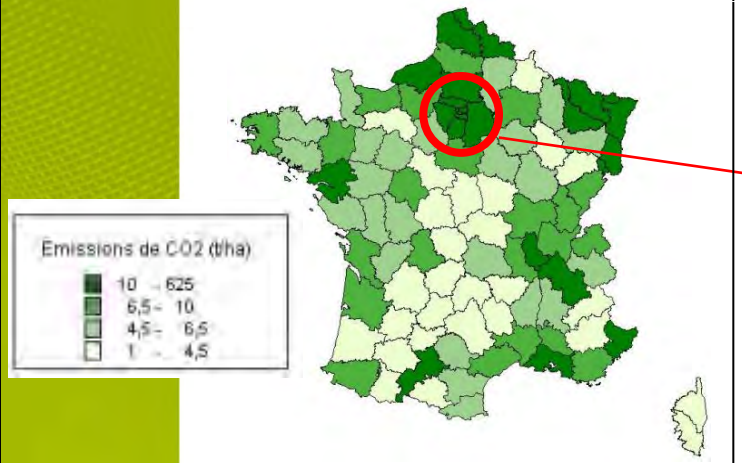


308MtCO2/an

551000km² (675000km²)

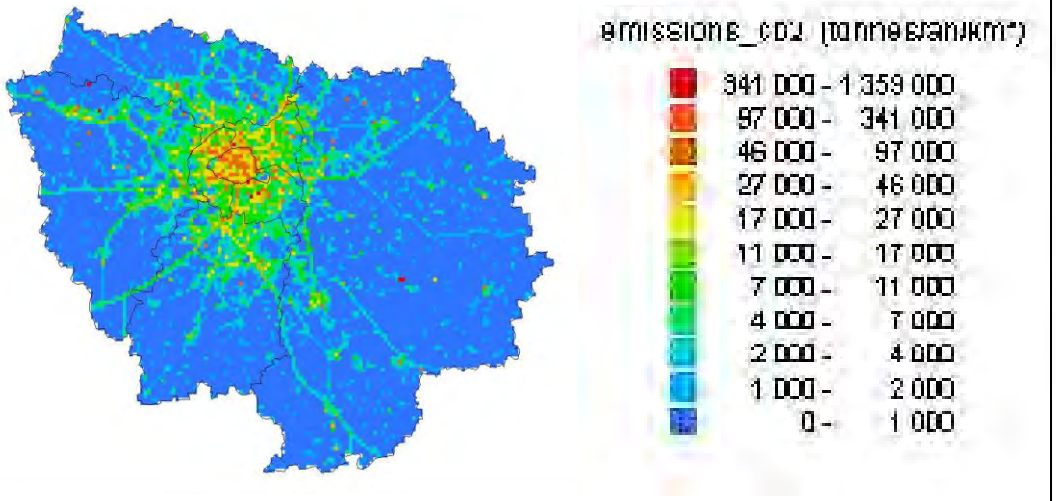
Why studying CO_2 emissions from Paris?

- Paris is the 3rd european megacity (and ~20th 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 independant verification of inventories and uncertainties unknown



CO_2 emissions per region (CITEPA)

90% of the population of IDF are concentrated in 20% of its area



HR CO_2 emissions for Ile-de-France 2007 (AIRPARIF)

Synergy between observations and modeling

Mesoscale network (CO_2, CO, boundary layer height, Radon 222, CO_2 flux)

Intensive campaigns (^{14}C, ^{13}C, ^{12}C, O18, O16, CO_2 biospheriques fluxes, co-MEGAPOLI, PBL height/CO_2)

LSCE

LMD

INRA

AIRPARIF

CO_2 flux calculation by observational methods

-boundary layer budget

-Radon 222/CO_2 correlations – CO, ^{14}C, K… correlations with CO_2

LSCE

LMD

CO_2 flux calculation by inverse modeling at high-resolution

-HR inventories

-AROME/Meso-NH + TEB

-LPDM

-ECMWF/CHIMERE

CNRM

LSCE

INRA

AIRPARIF

IER

EDGAR

CITEPA

Synergy :

-intercomparisons of all results and inventories for CO_2 emissions and CO_2/CO ratios

-error estimates

-conference of societal research

-communication to local authorities

All and

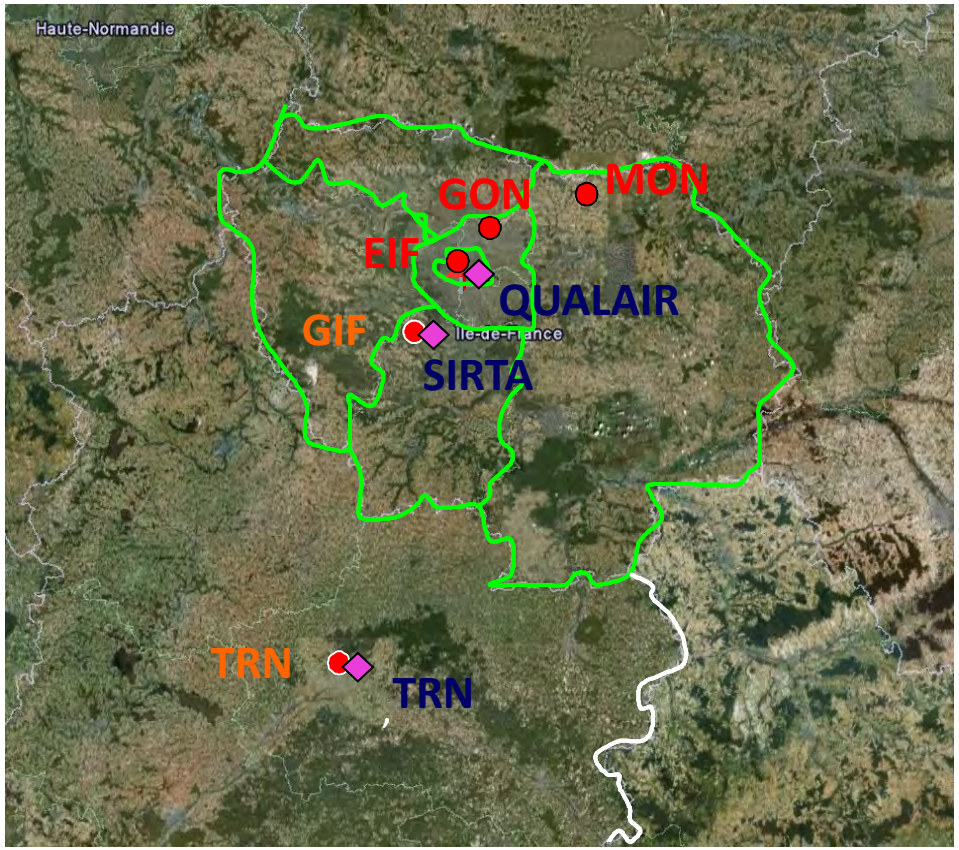
REEDS

Association of CO2-MEGAPARIS and CARBOCOUNT

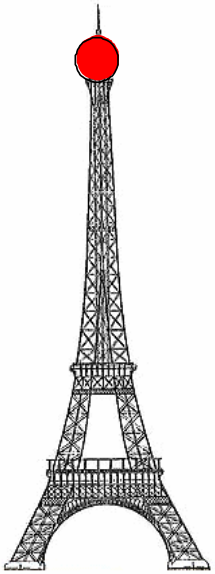
The observation network

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

NE



SW

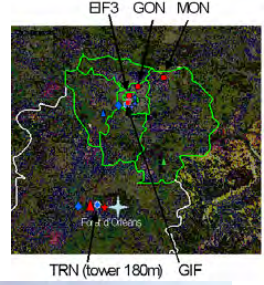


Mobile observations with two cars (LIDAR and CO2)

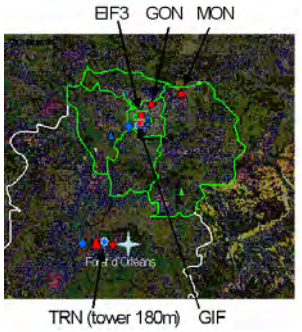
along the stations GIF-EIF-GON-QUALAIR-SIRTA

• Montgé-en-Goële

Station de fond rural Nord-Est

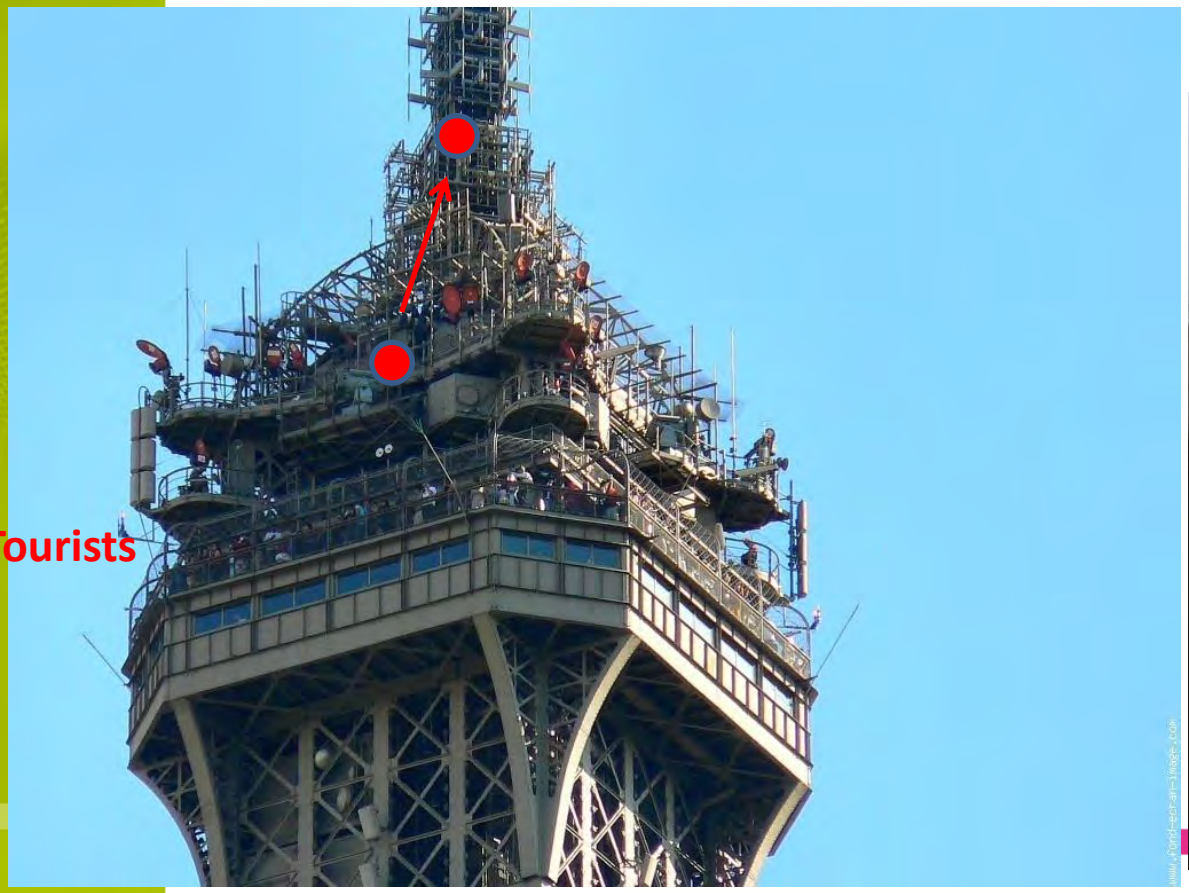


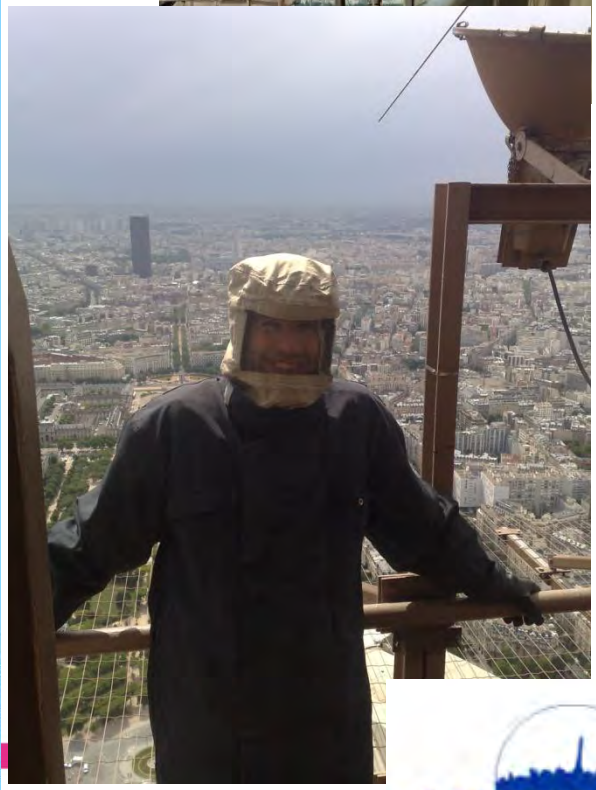
Gonesse station: station péri-urbaine NE



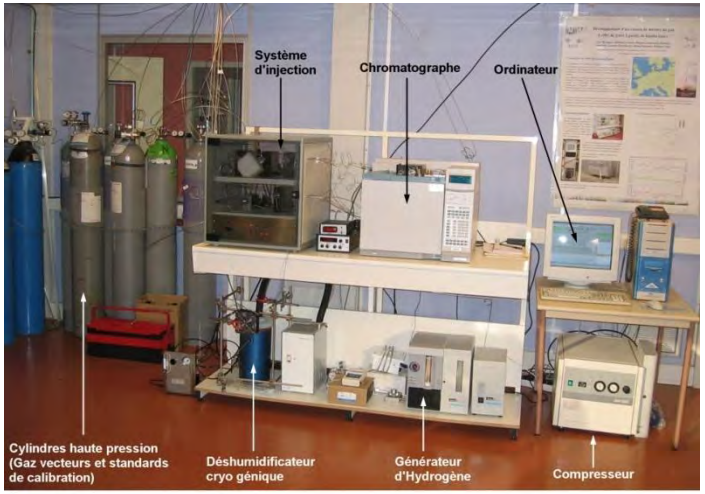
Mât 15 mètres

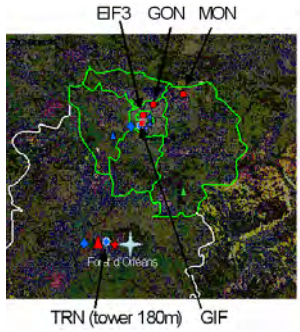
Eiffel tower (6th floor)



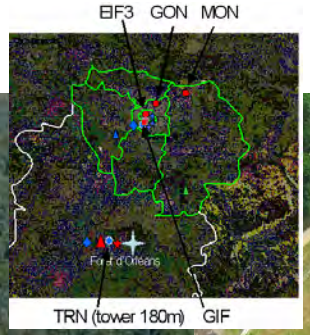


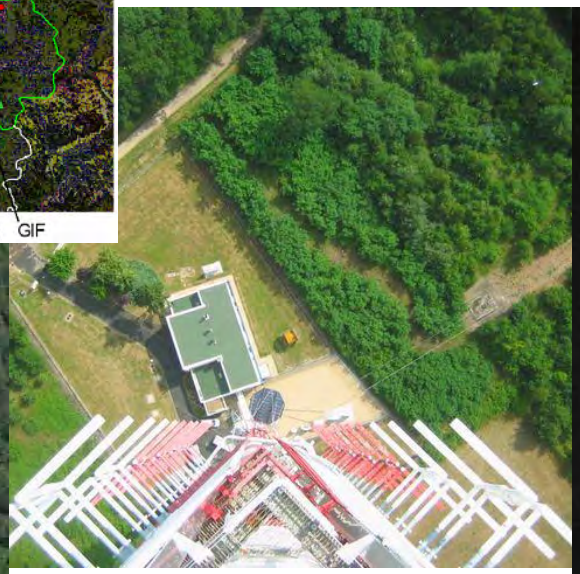
GIF: station péri-urbaine Sud-Ouest





Traînou : station de fond rurale Sud-Ouest

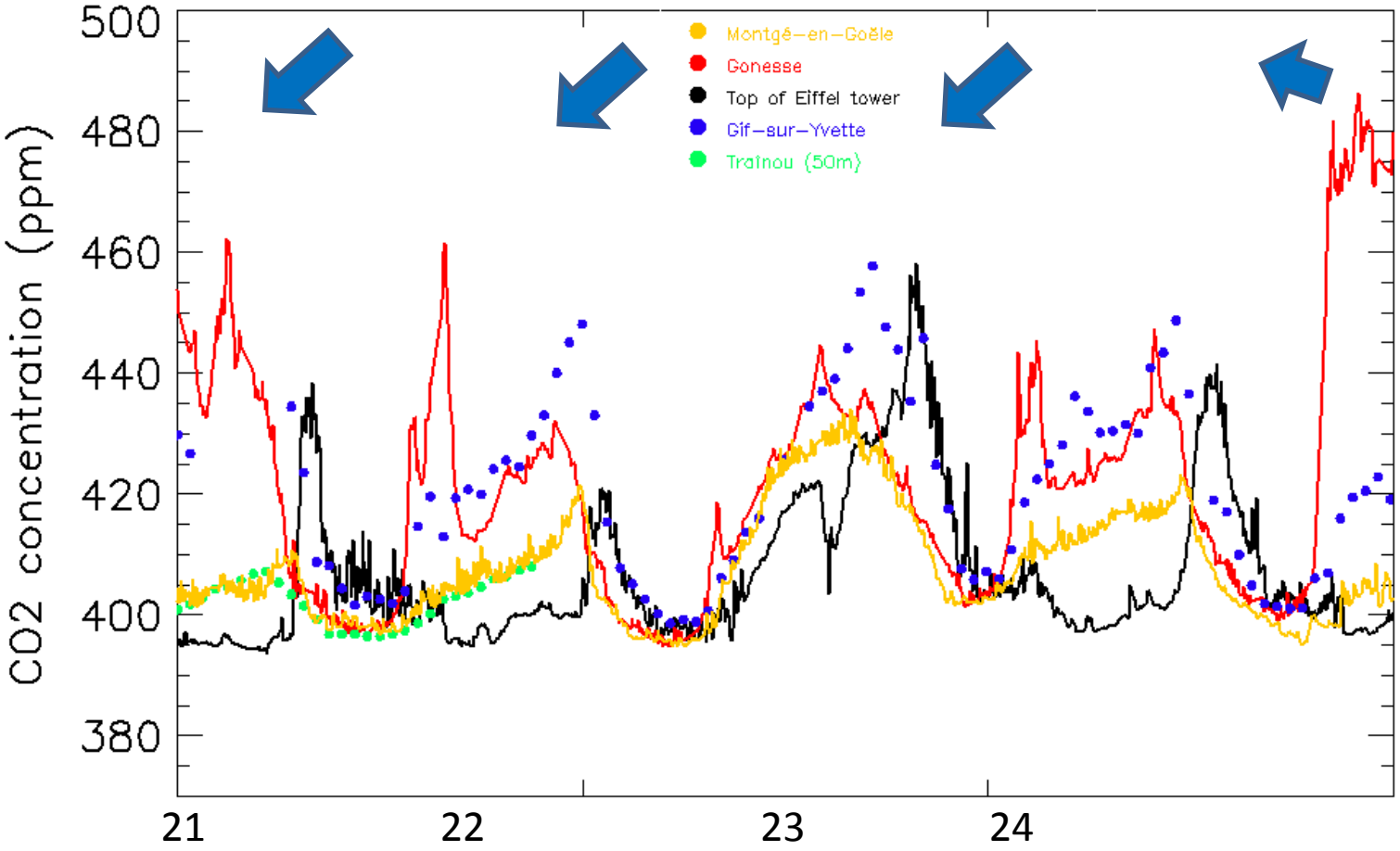




Paris urban heat island effect: Impact on the dilution factor of CO2 emissions

CO2 concentration from the 5 stations of the network:

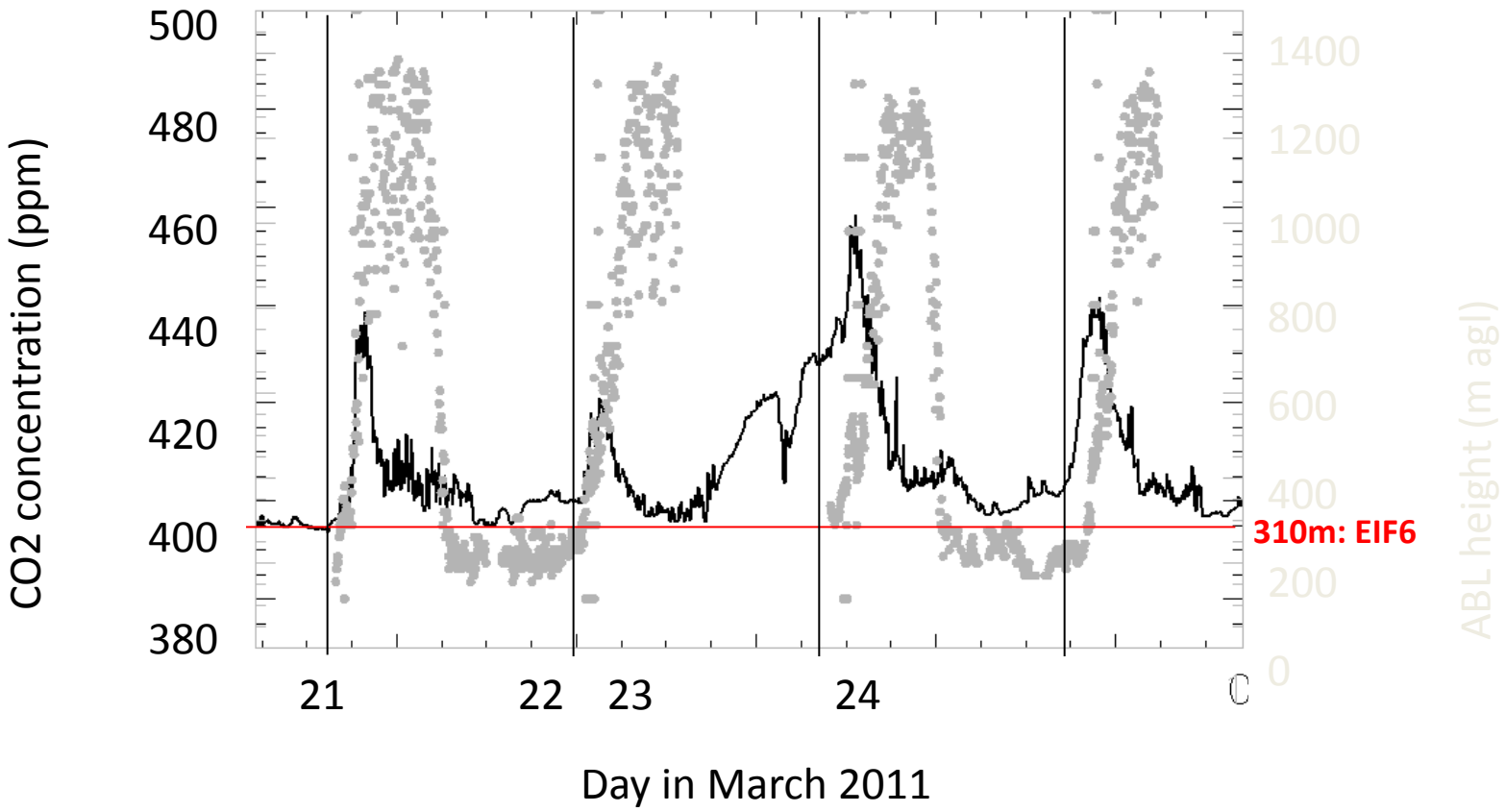
A case study on 21-24 March 2011



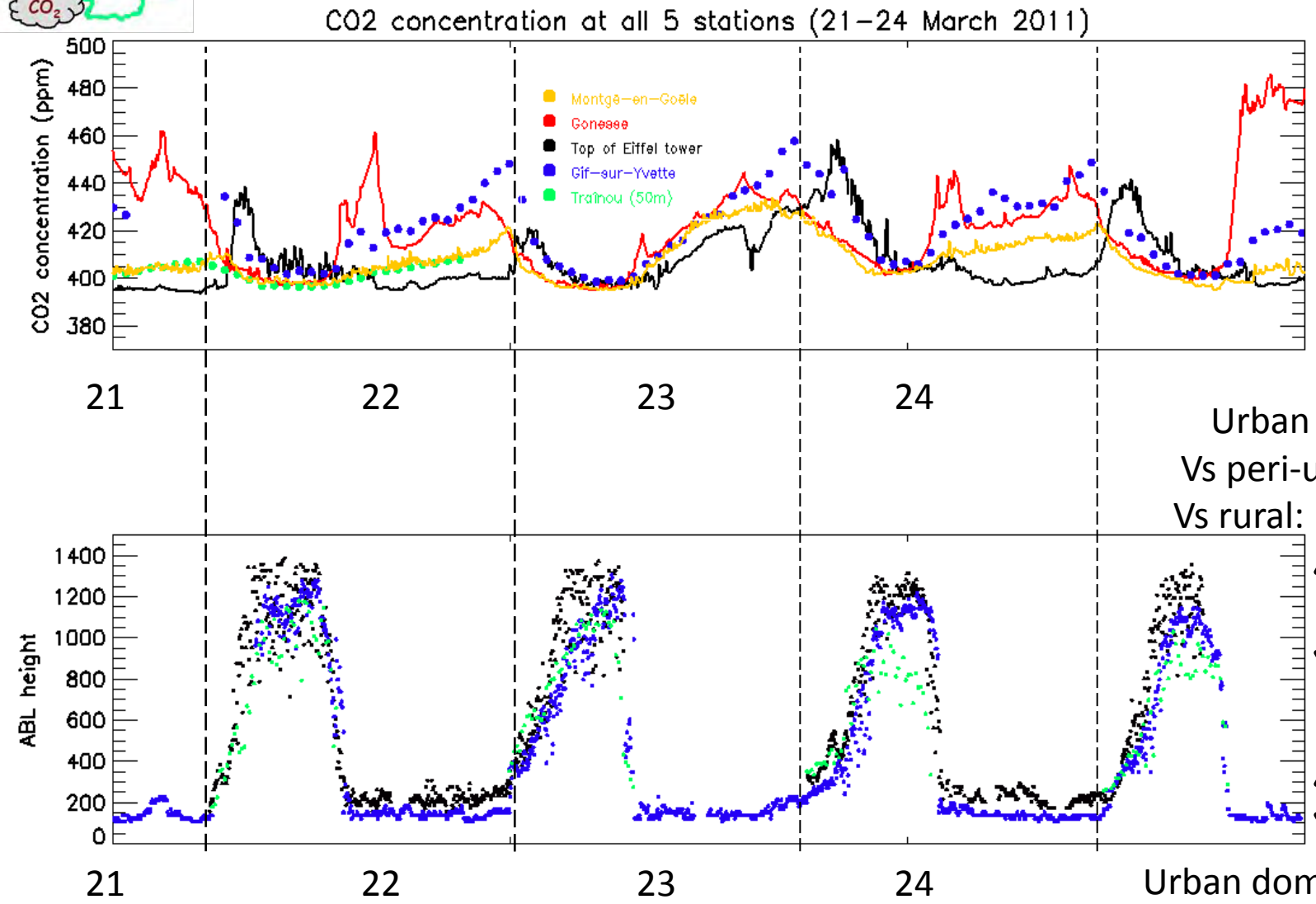
Wind sector

Day in March 2011

The case of the top of the Eiffel tower



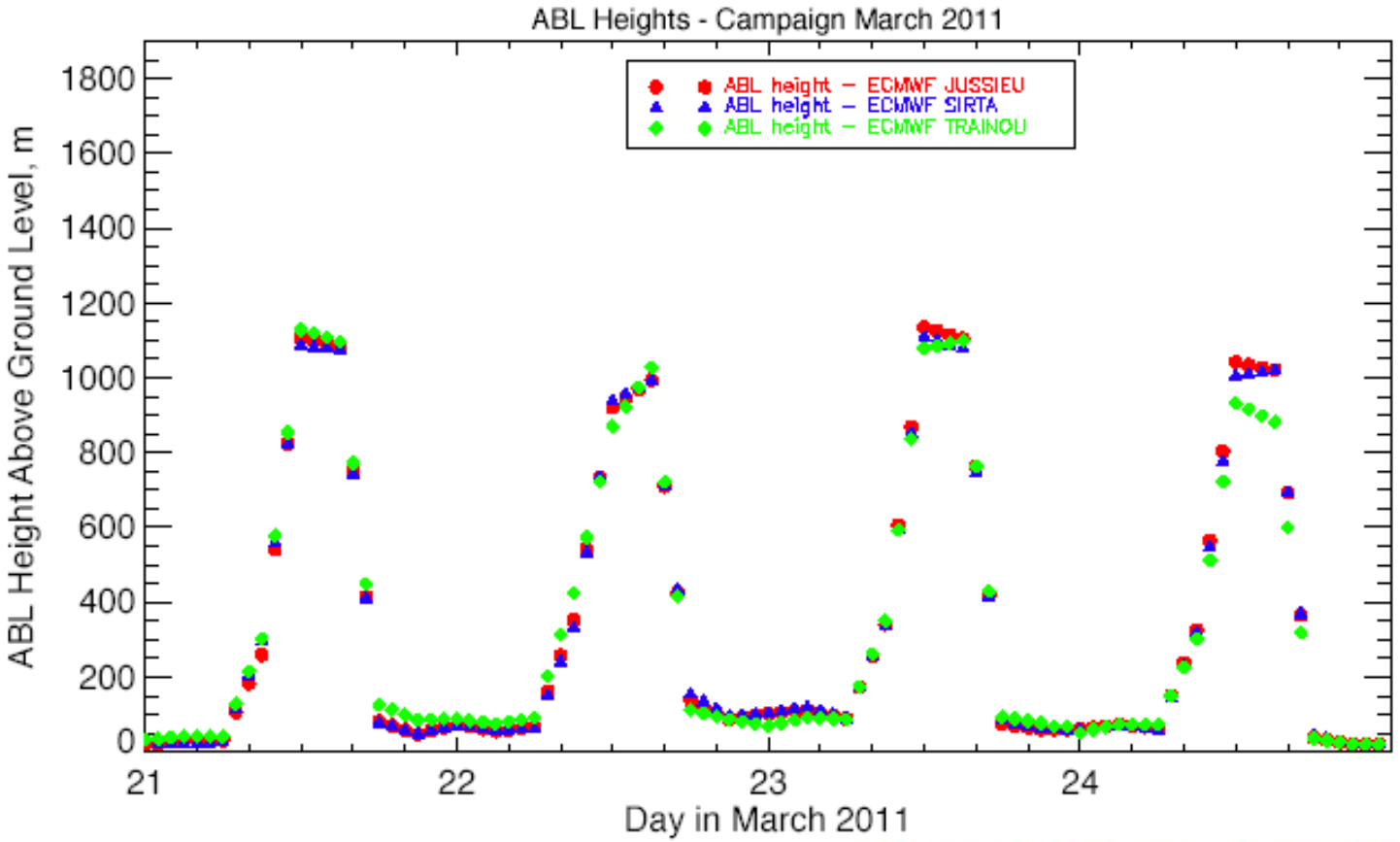
Effect of the urban heat island on the dilution of CO2 emissions



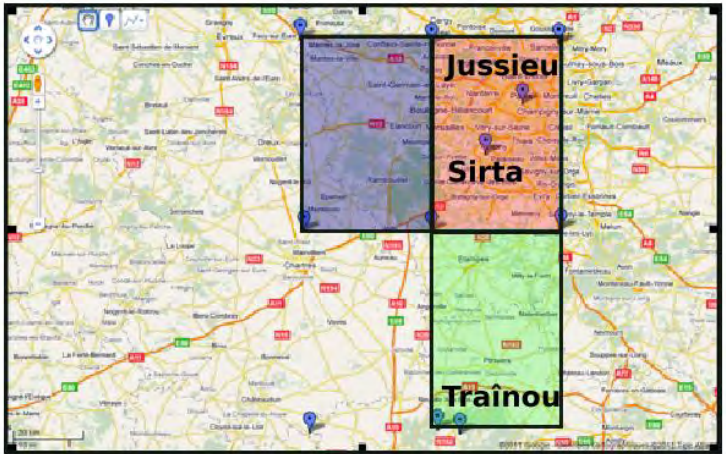
Urban dome/ Day
Vs peri-urban:10-20%
Vs rural: 15-40%

Urban dome /Night
Vs peri-urban20-30%
Vs rural >40%

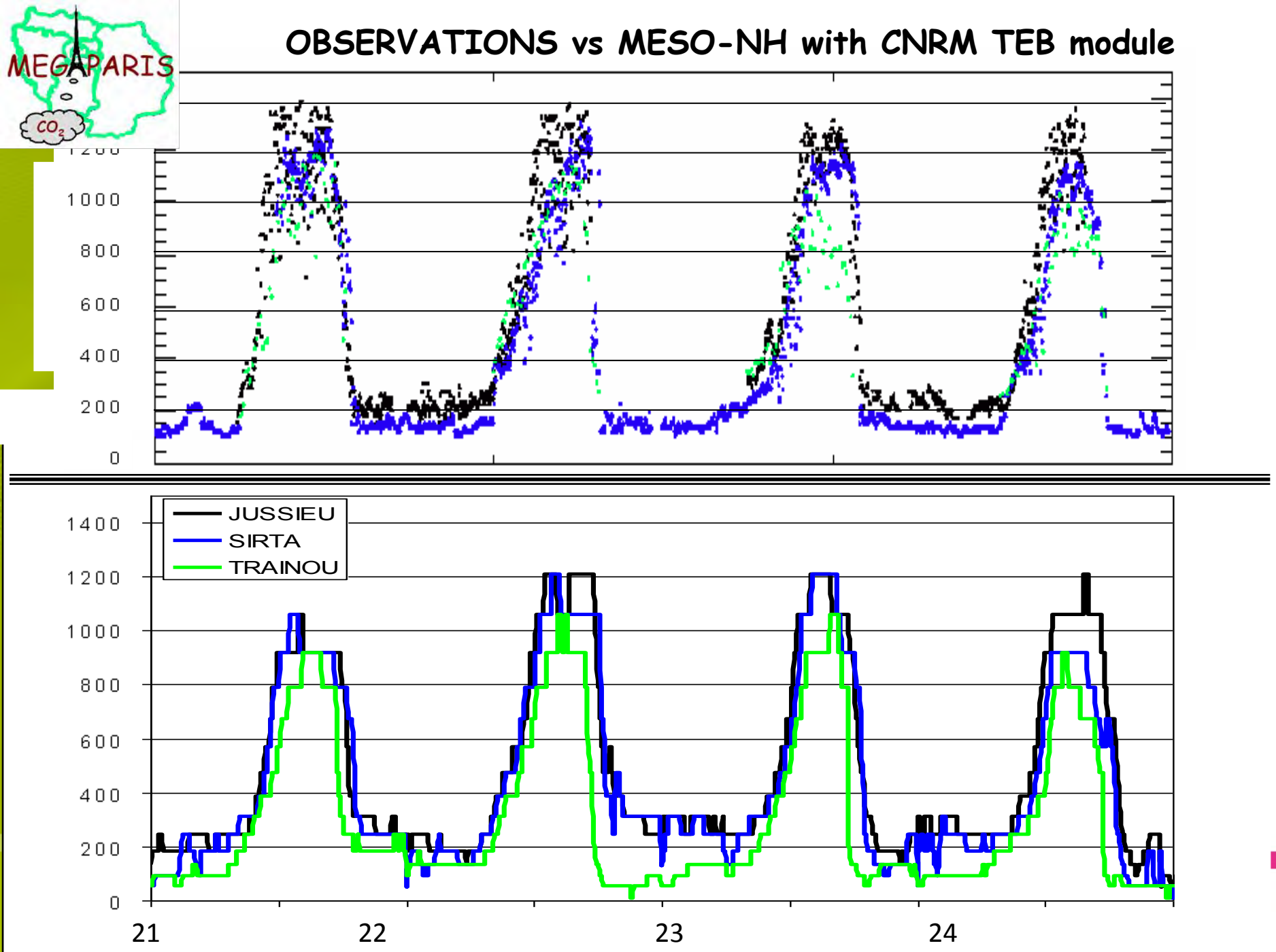
ECMWF (50 x 50 km2)



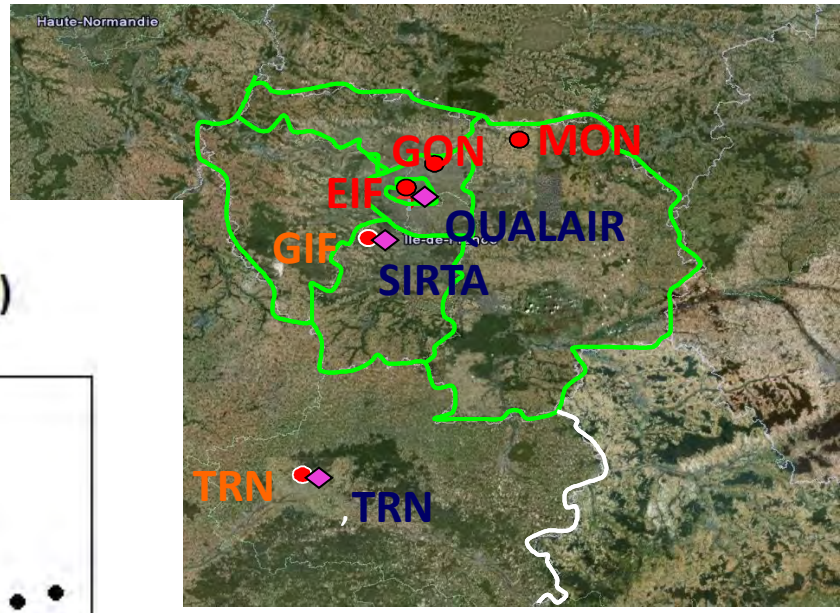
Generally no urban dome or incomplete
Strong underestimation of the ABL height at night (~60%)

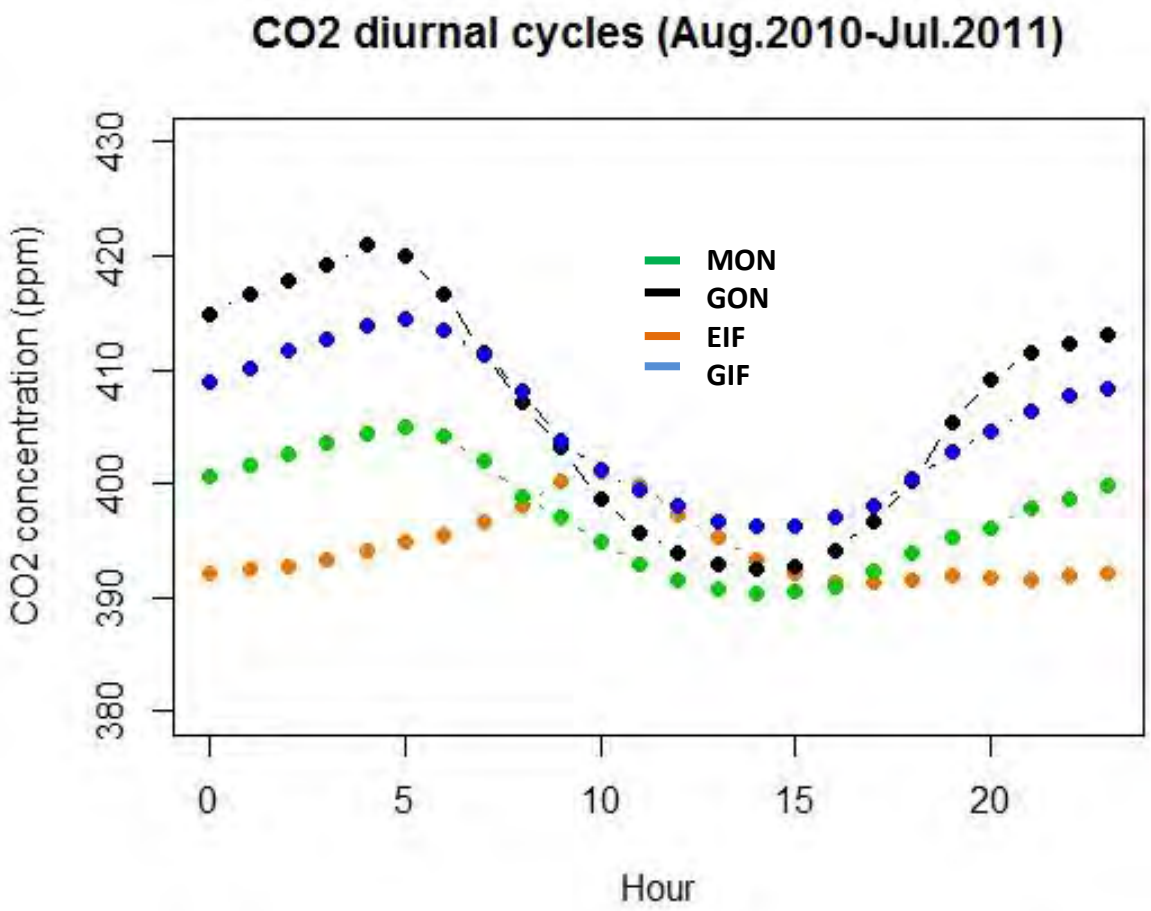


OBSERVATIONS vs MESO-NH with CNRM TEB module



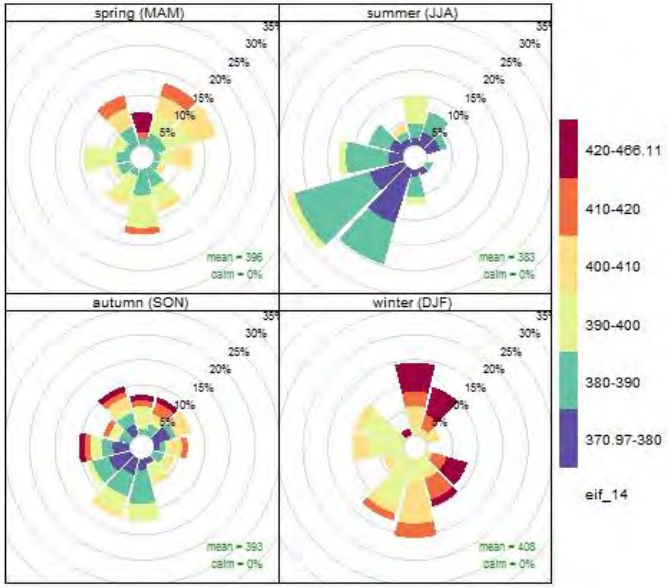
Paris CO2 urban dome
Wind study





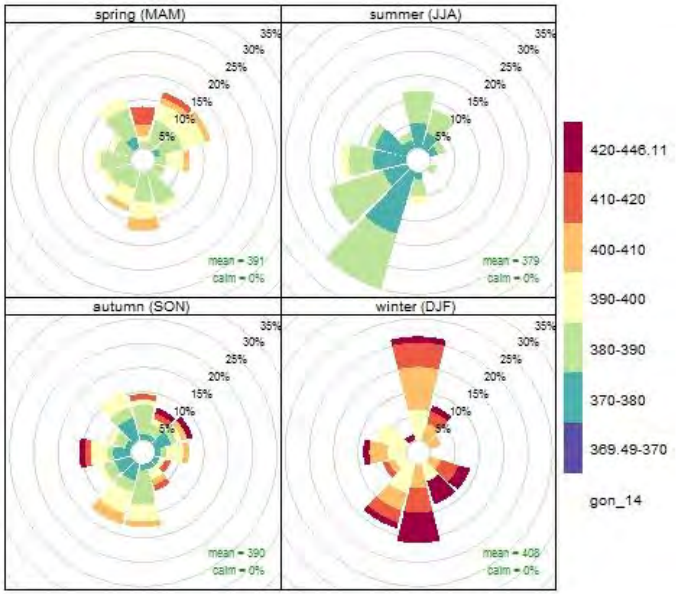
At the Eiffel tower station, we observe a flushing of the nocturnal layer during the ABL development.

EIF



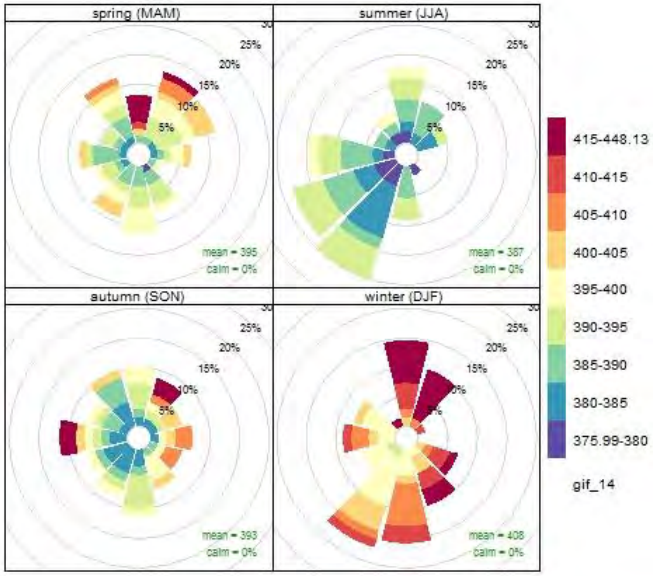
Frequency of counts by wind direction (%)

GON



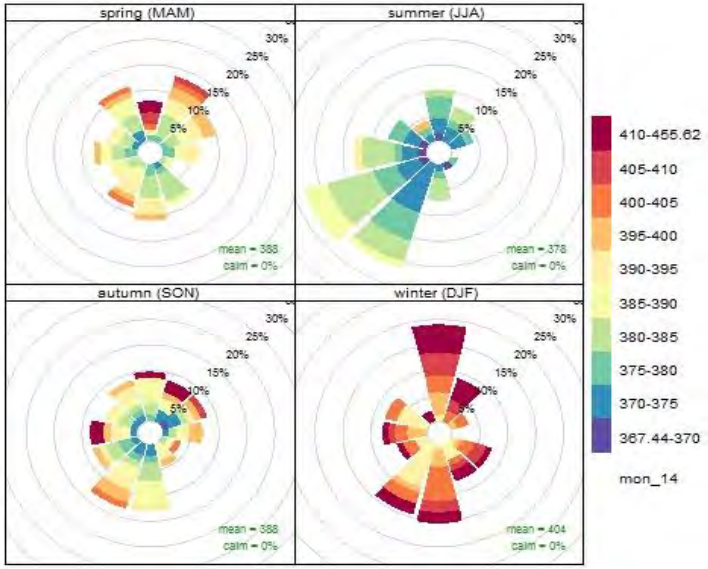
Frequency of counts by wind direction (%)

GIF



Frequency of counts by wind direction (%)

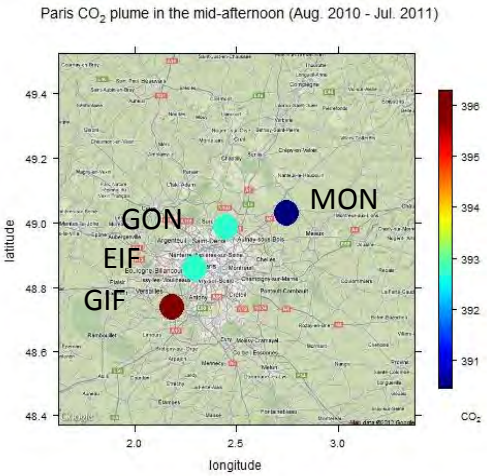
MON

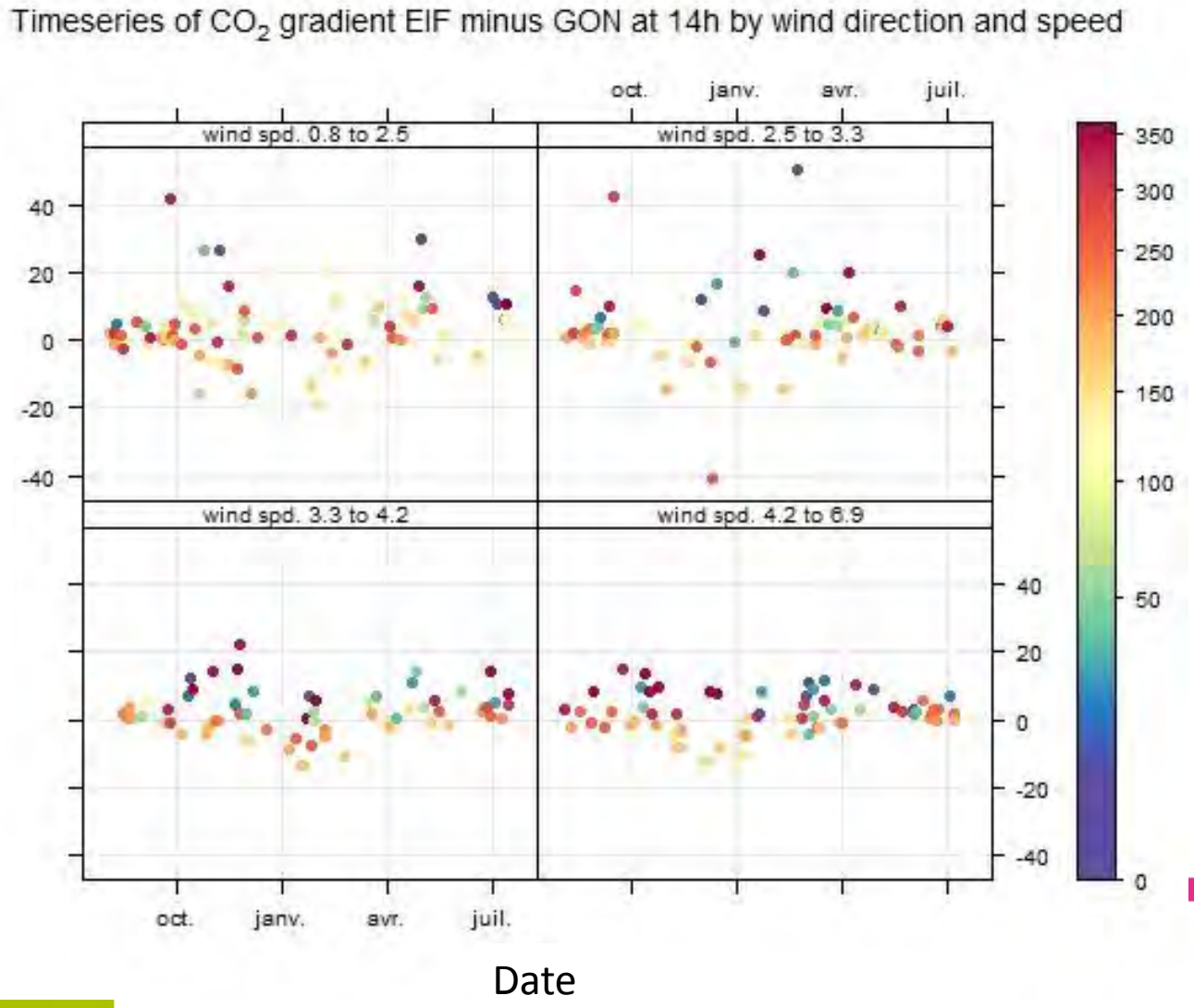


Frequency of counts by wind direction (%)

EIF vs GON
Wind direction and speed

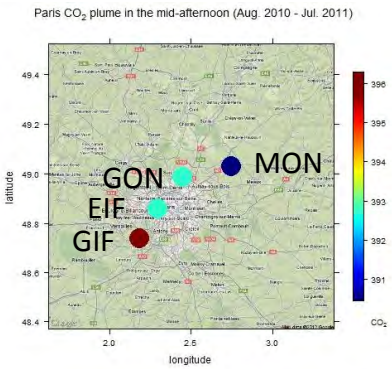
Paris mean CO2 plume in mid-afternoon

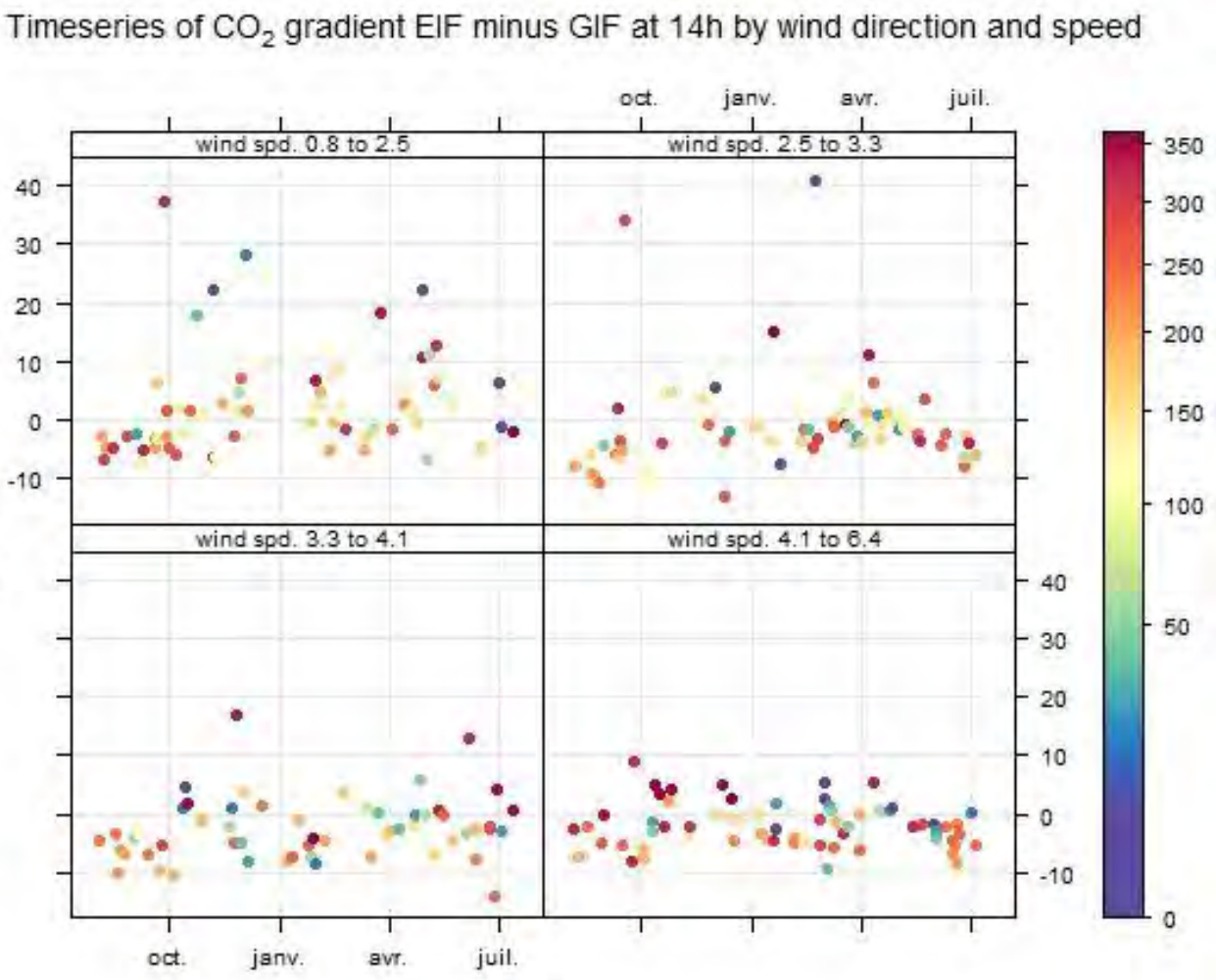




EIF vs GIF
Wind direction and speed

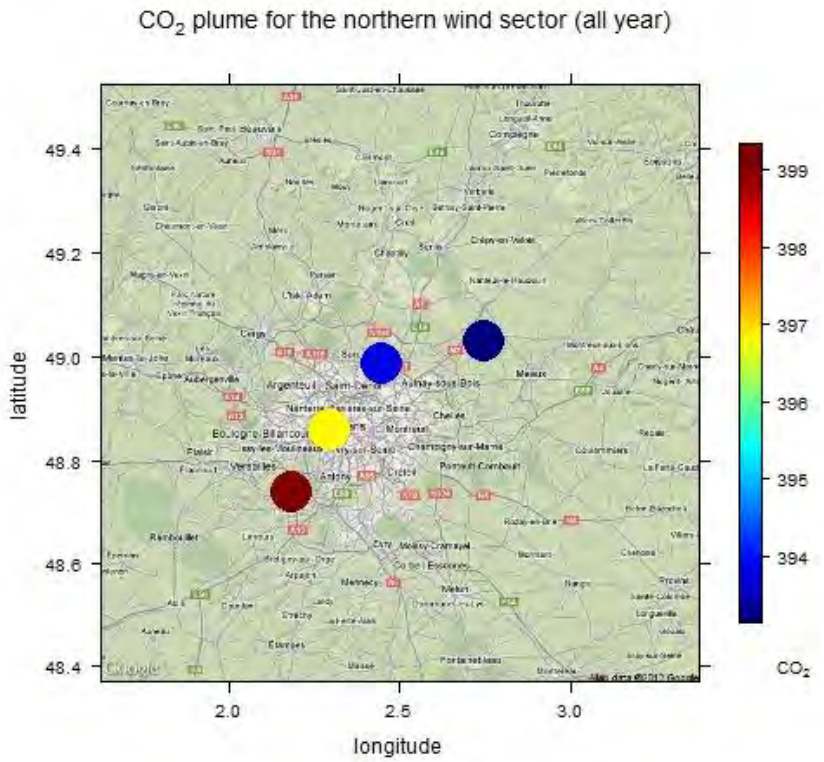
Paris mean CO2 plume in mid-afternoon





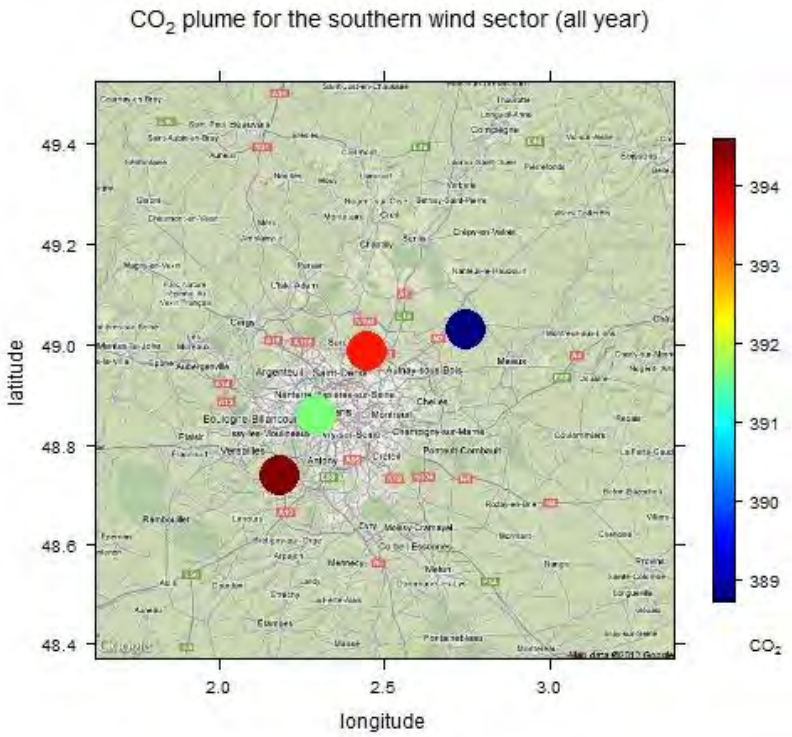
Averaged gradient per wind sector

Northern sector



GON to EIF
ΔCO2 = 3.5ppm

Southern sector



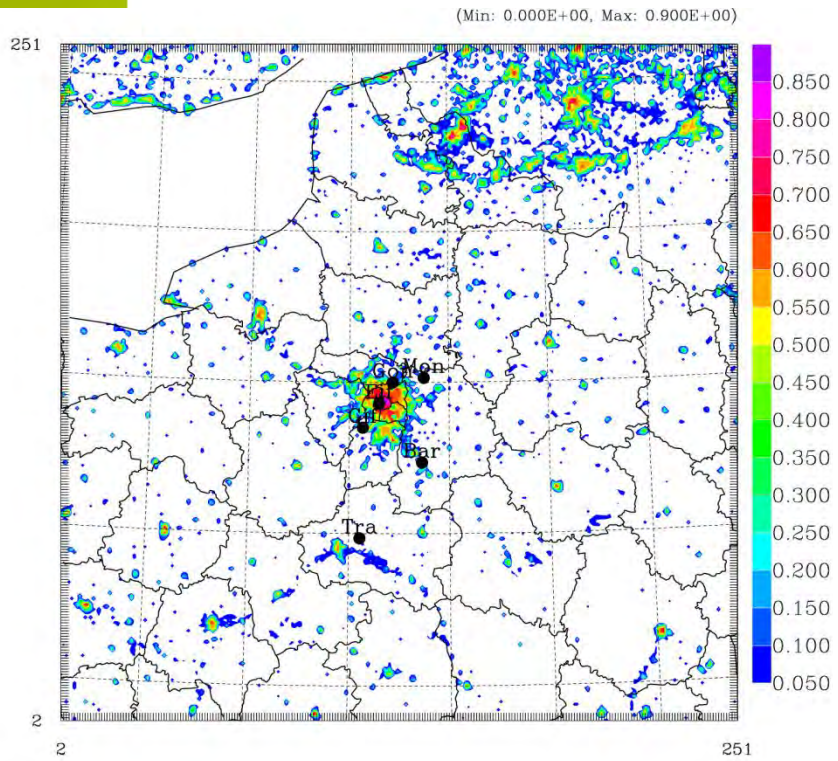
EIF to GON
ΔCO2 = 2.1 ppm

Modeling

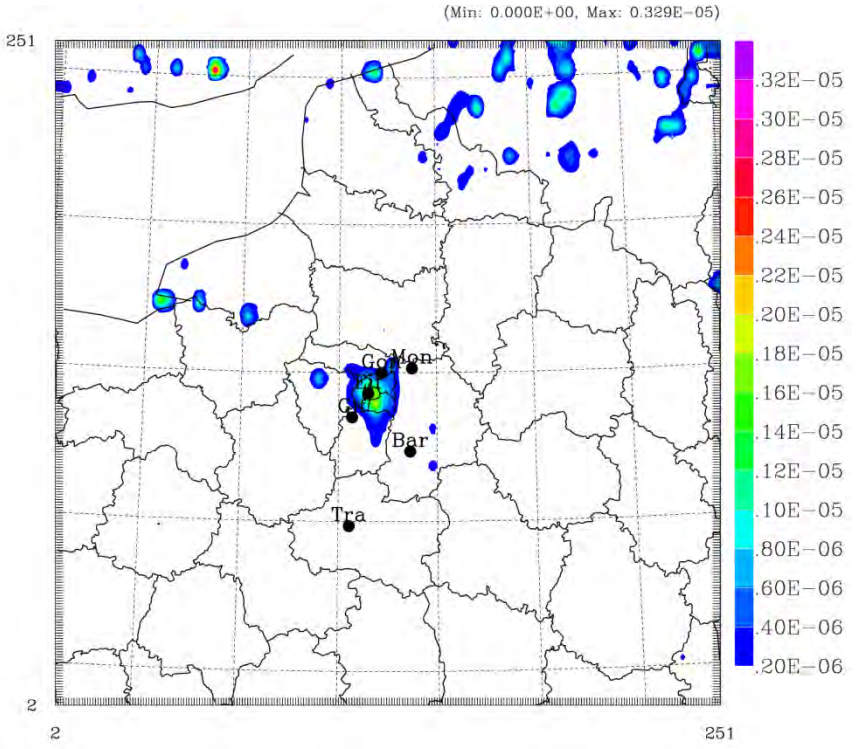
Direct modeling (CNRM)

Physiographic data from ECOCLIMAP (1km resolution)

Anthropogenic CO2 emissions from Stuttgart (10km resolution)



Town fraction



CO2 emissions (ppp) 21/03/2011/12UTC

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

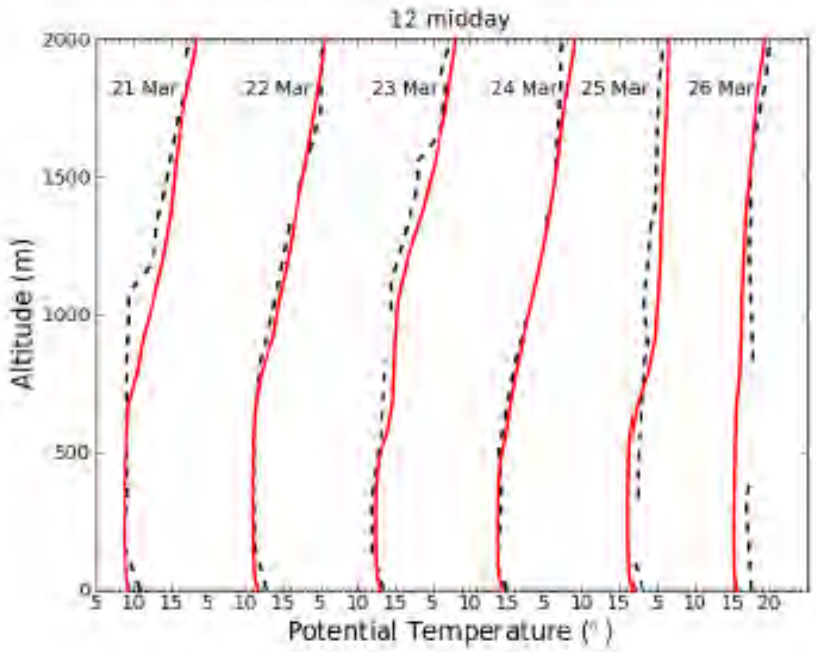
March campaign : Meteorology

Measurements

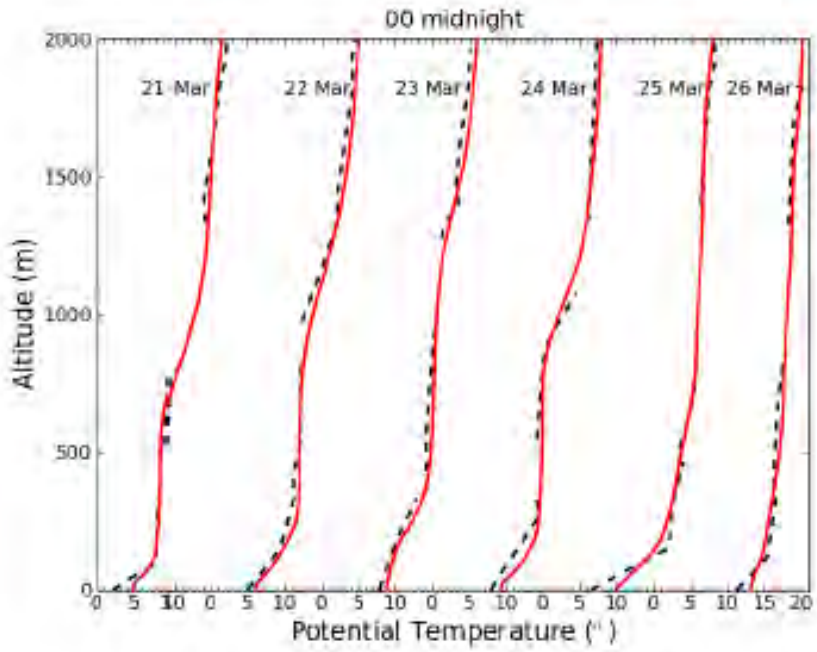
Meso-NH

Trappes soundings

Midday



Midnight



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

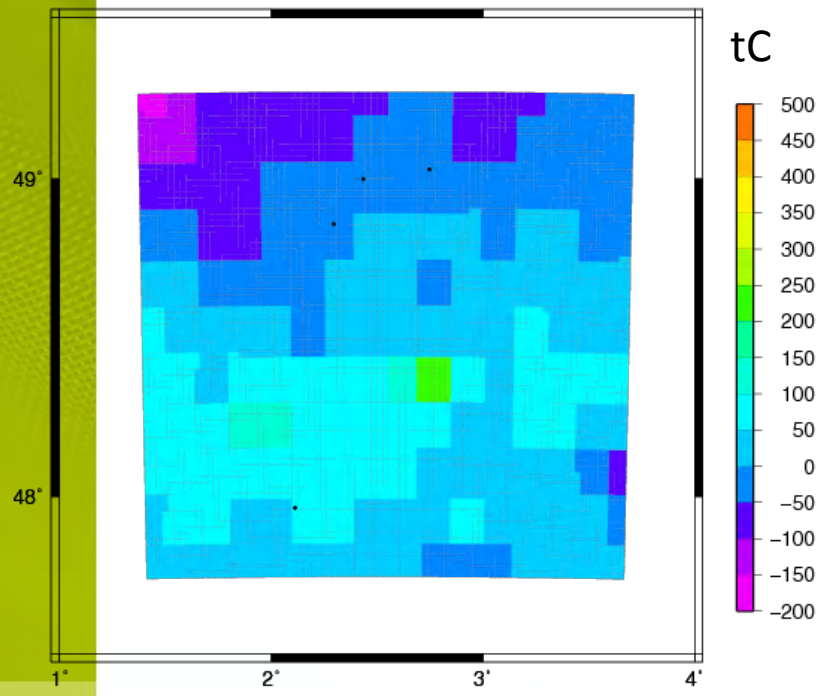
- Good representation of the inversion
- Slight overestimation of the near surface temperature

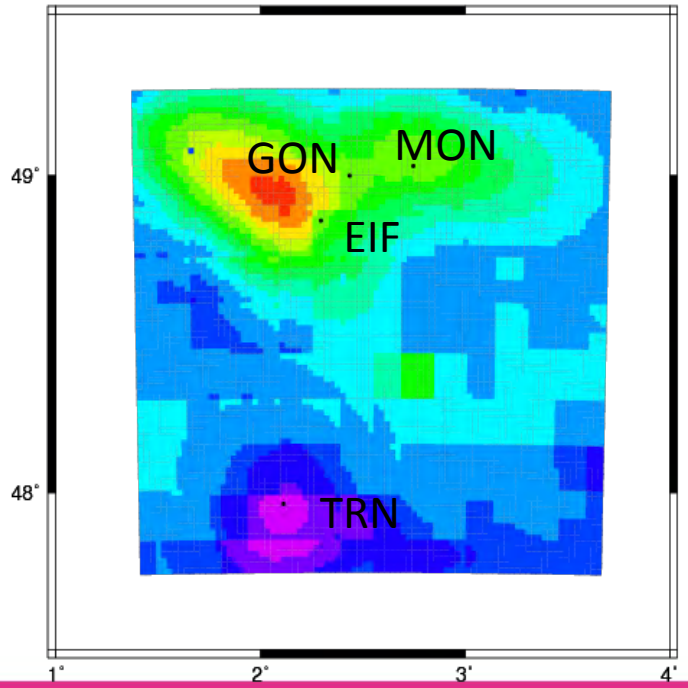
Inverse modeling (LSCE)

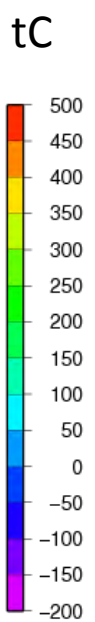
Flux prior/corrigés

22/09/2010 à 12:00 UTC

ECMWF/CHIMERE







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

THANK YOU « Et al » :