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Vienna, Austria, 22-27 April 2012

Remote sensing of GHG over Paris megacity and Orléans forest using ground-based QualAir FTS and TCCON-Orléans

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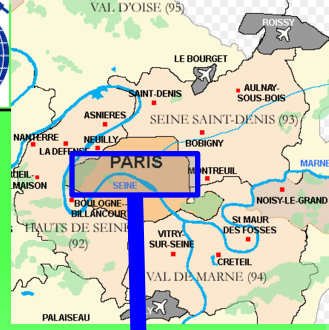
QualAir FTS
instrumental description

QualAir FTS at Paris megacity

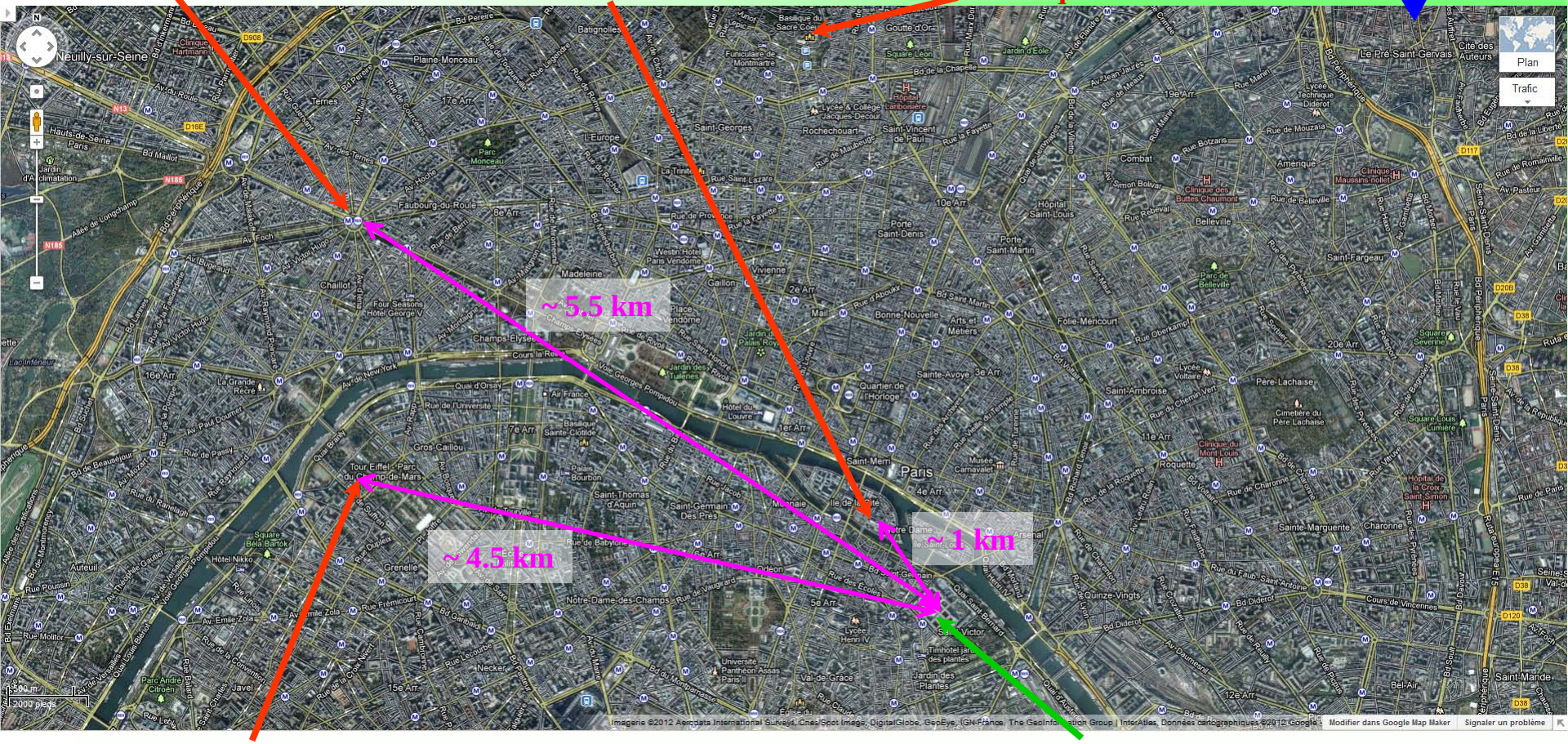
- 3rd European megacity
- More than 2 millions inhabitants in the city of Paris
- More than 10 millions inhabitants in the Paris urban area



Arc de Triomphe

Notre-Dame de Paris

Basilique du Sacré Cœur



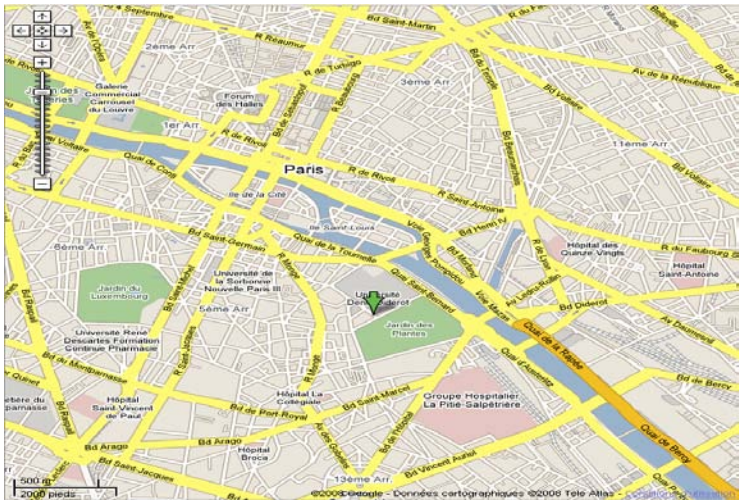
Tour Effel

QualAir platform [48.846°N, 2.356°E]

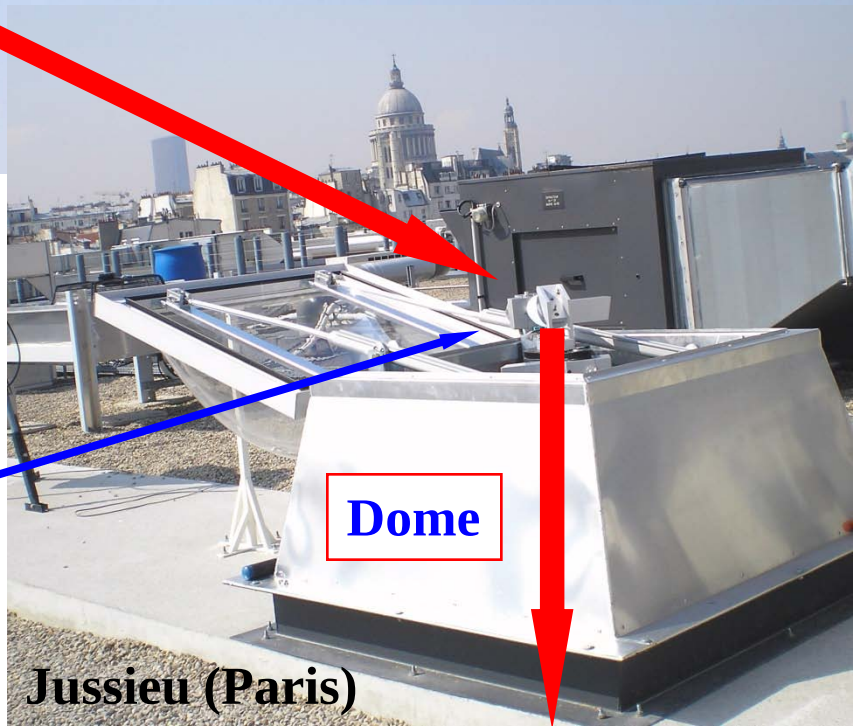
Té *et al.*, EGU General Assembly 2012, Vienna, 22-27 April 2012

Sun trajectory

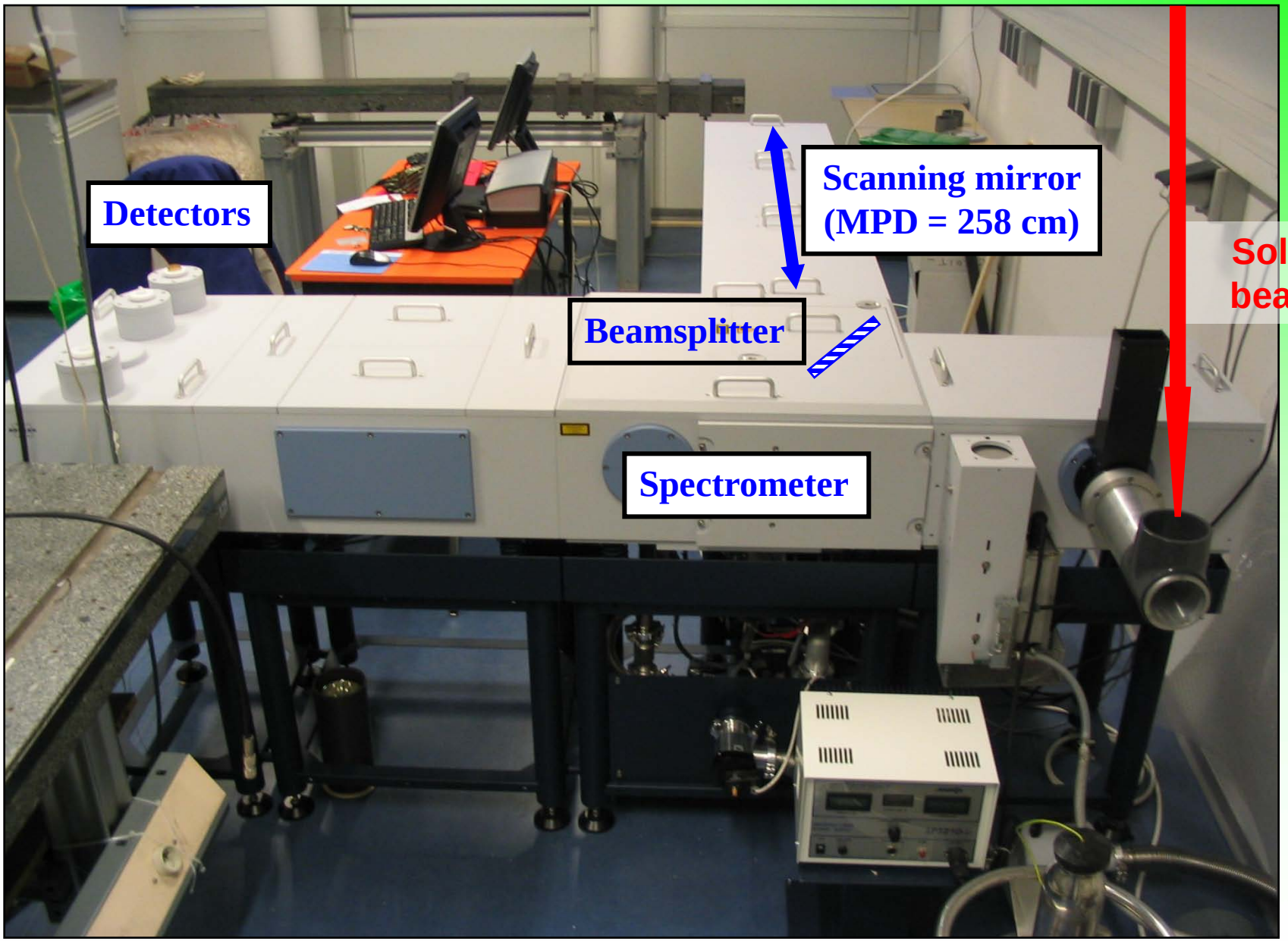
(Té *et al.*, RSI, 2010)



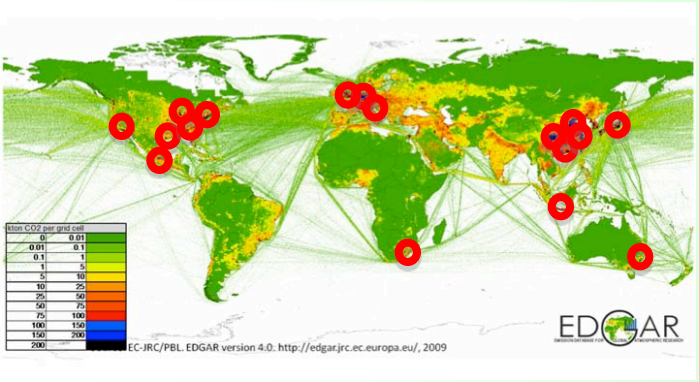
Sun-tracker



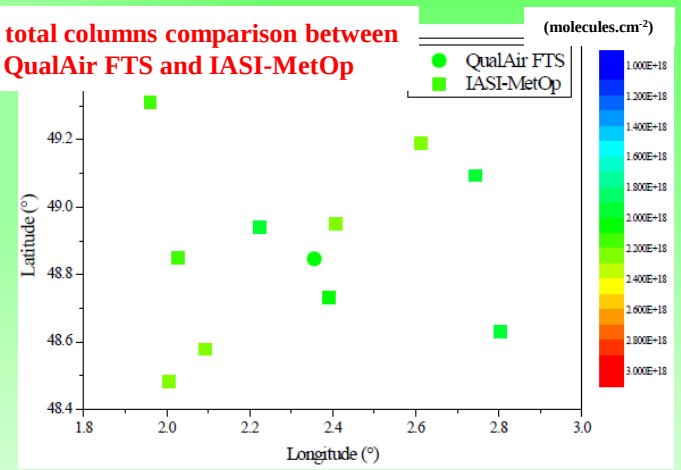
QualAir Fourier transform spectrometer (QualAir FTS)



Ground-based FTIR observations in Paris megacity

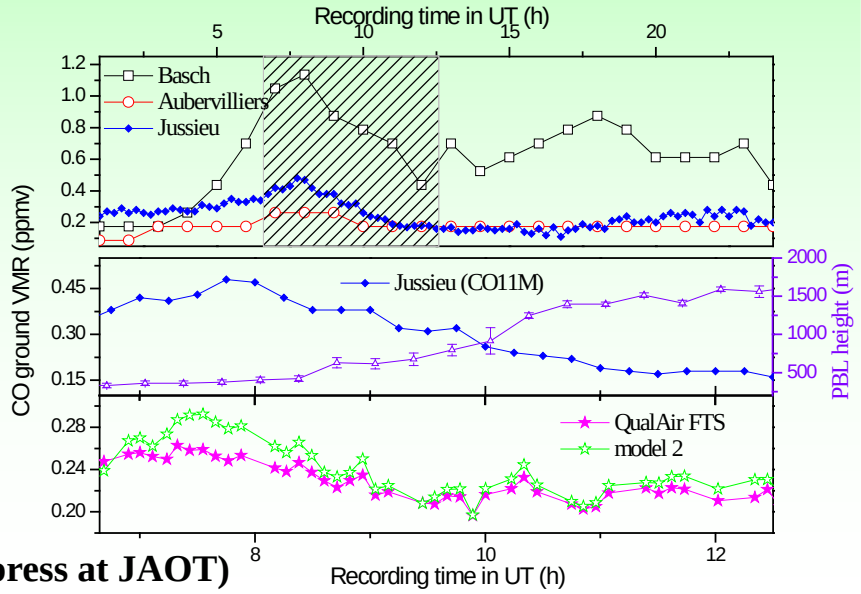


- 75% of fossil CO_2 is emitted by urbanized areas
- Few existing sites in the world (Paris, LA, Mexico …)
- GHG monitoring from space (GOSAT, CarbonSat, …)



LPMAA instruments for atmospheric sounding :

- Fourier transform spectrometer (QualAir FTS) for remote sensing measurements
- CO analyzer (CO11M) for *in-situ* measurements of carbon monoxide
- Oregon Scientific met. station
- SIMCO for *in-situ* measurements of CO_2 and $^{13}CO_2$ concentration (during specific measurements campaign)



(Té *et al.*, in press at JAOT)

QualAir FTS retrieval results from PROFFIT algorithm

(Hase *et al.*, JQSRT, 2004)

QualAir FTS data

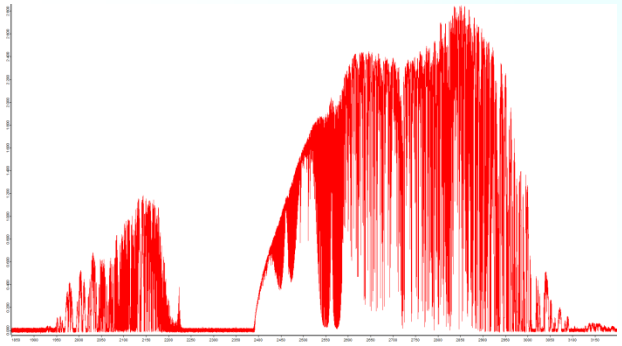
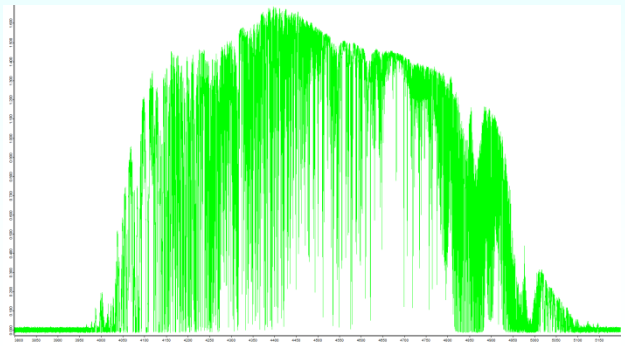
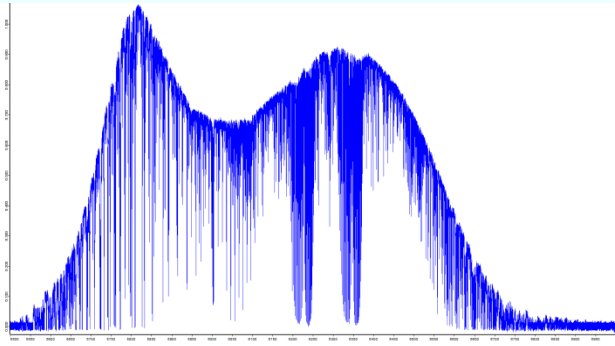
- Maximum optical path difference of 258 cm (~ 0.0024 cm^{-1})

- InSb detector combined with 3 different optical filters (same as NDACC ones) :

  - 1850-3200 cm^{-1} : CO, O_3, OCS, HCl, NO_2, CH_4, N_2O, CO_2, H_2O …
  - 3800-5200 cm^{-1} : CO_2, CH_4, N_2O, HF, CO, H_2O …
  - 5500-7200 cm^{-1} : CO_2, CH_4, H_2O …

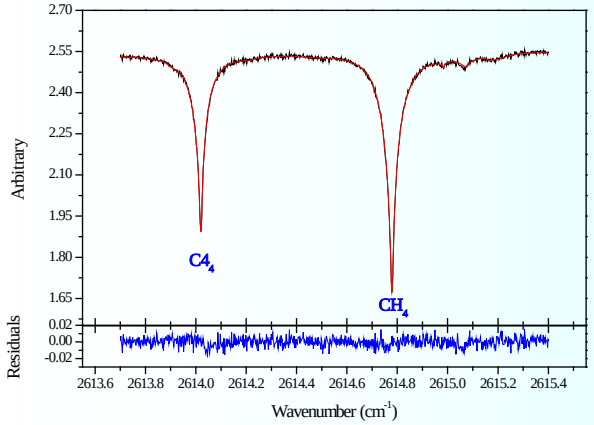
- Around 1900 spectra from March 8th 2011 to March 30th 2012 used to retrieve the concentrations of CO_2, CH_4, N_2O and CO

- Most data are recorded in the spectral intervals of 1850-3200 cm^{-1}, only few in the NIR domain.

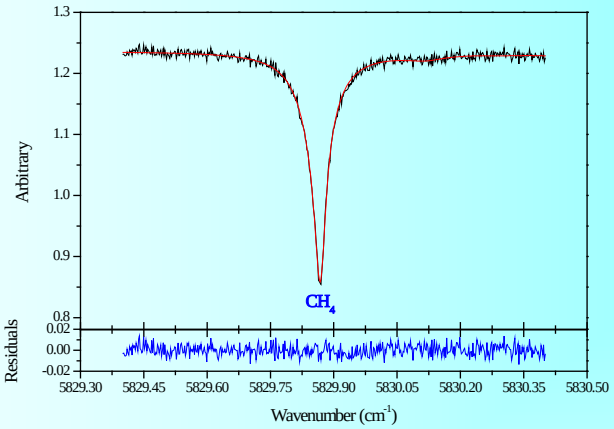
CH_4 retrievals

~ 3.8 µm



1 of the 5 used µ-windows

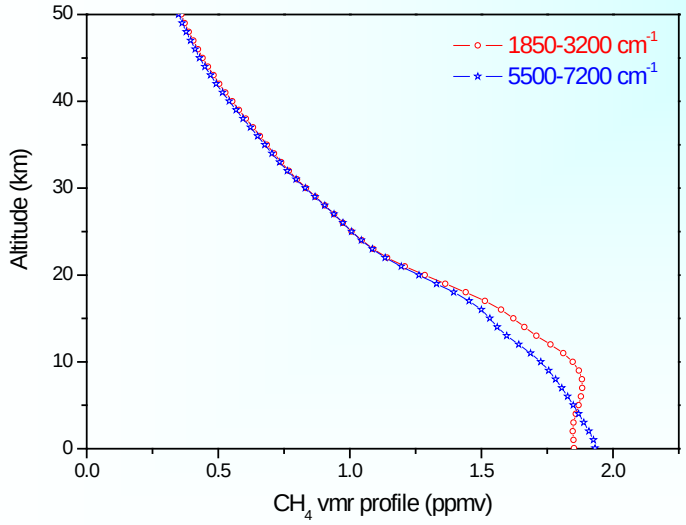
~ 1.7 µm

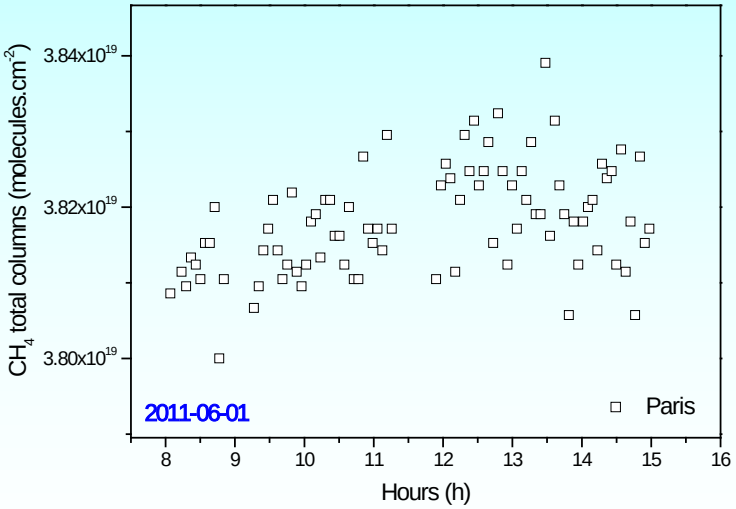


1 of the 4 used µ-windows

CH_4 total column (10^{19} molecules.cm^{-2})
- from 3.8 µm => 3.79
- from 1.7 µm => 3.76

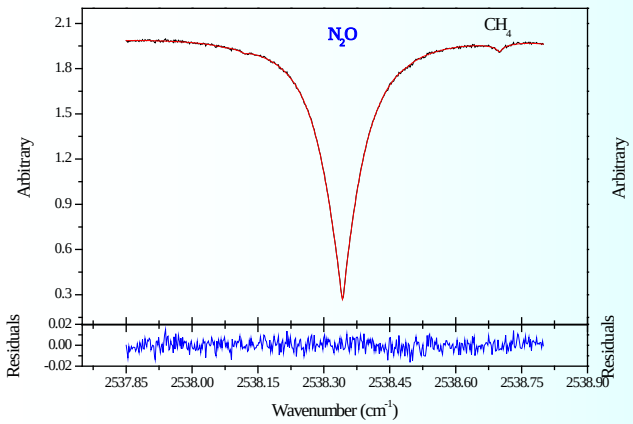
➔ Difference around 0.8%





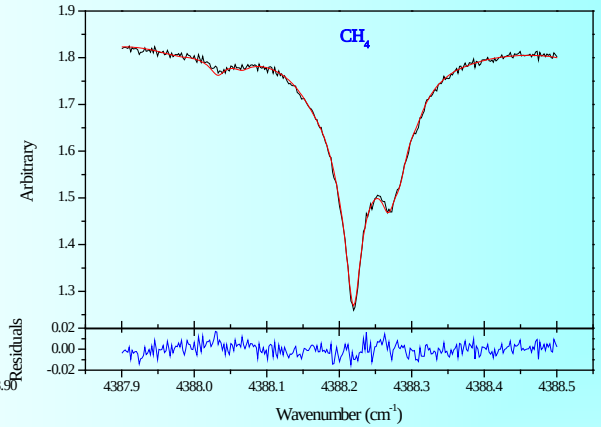
N_2O retrievals

~ 3.9 µm



1 of the 4 used µ-windows

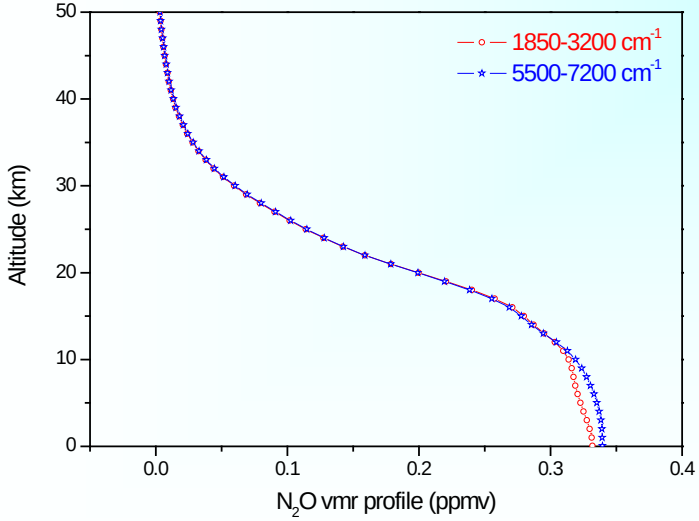
~ 2.3 µm

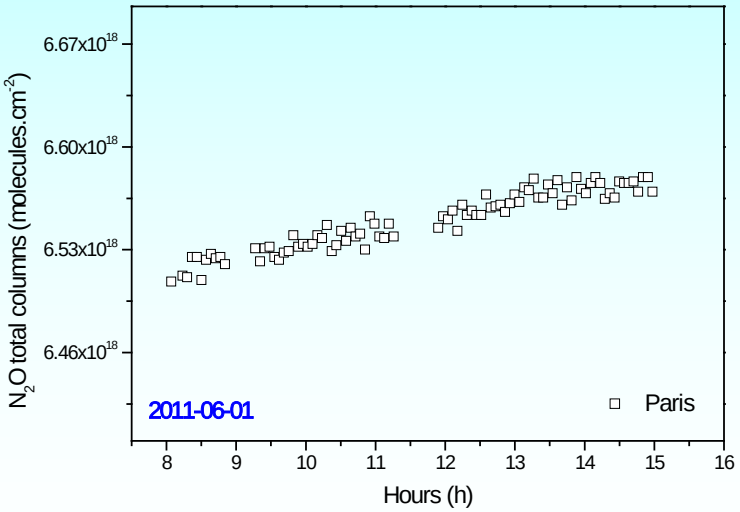


1 of the 4 used µ-windows

N_2O total column (10^{18} molecules.cm^{-2})
- from 3.9 µm => 6.53
- from 2.3 µm => 6.69

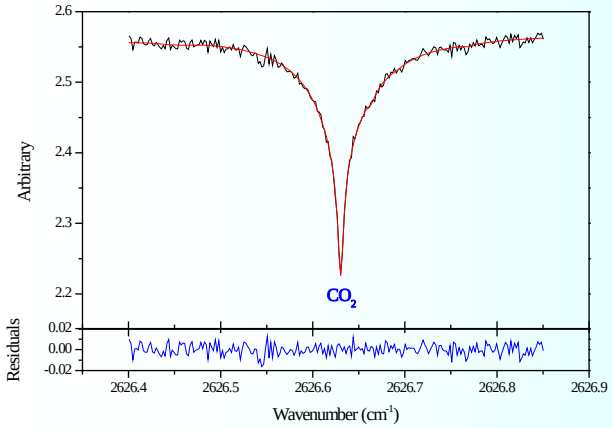
➔ Difference around 2.5 %





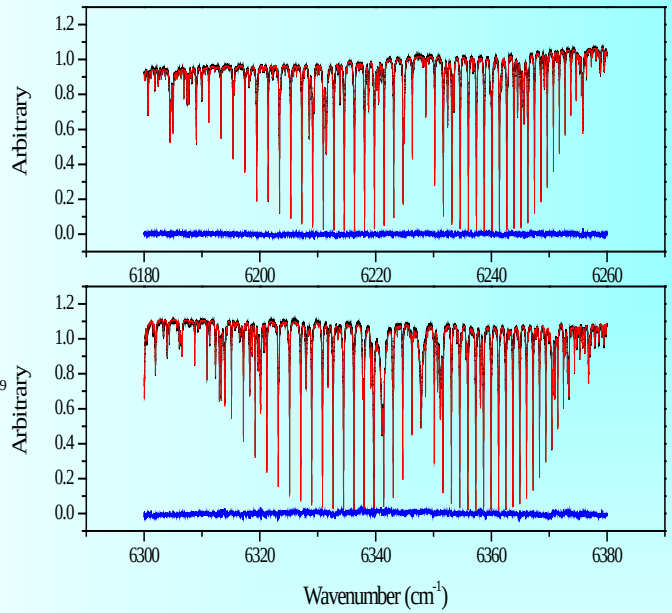
CO_2 retrieval

~ 3.8 µm



4 used µ-windows

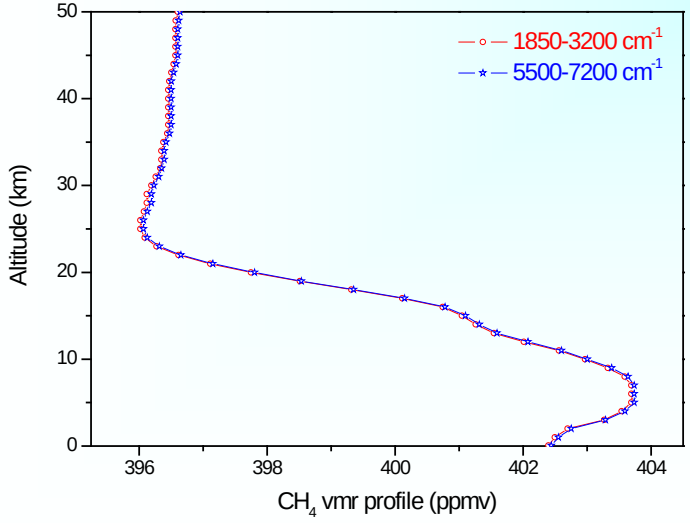
~ 1.6 µm

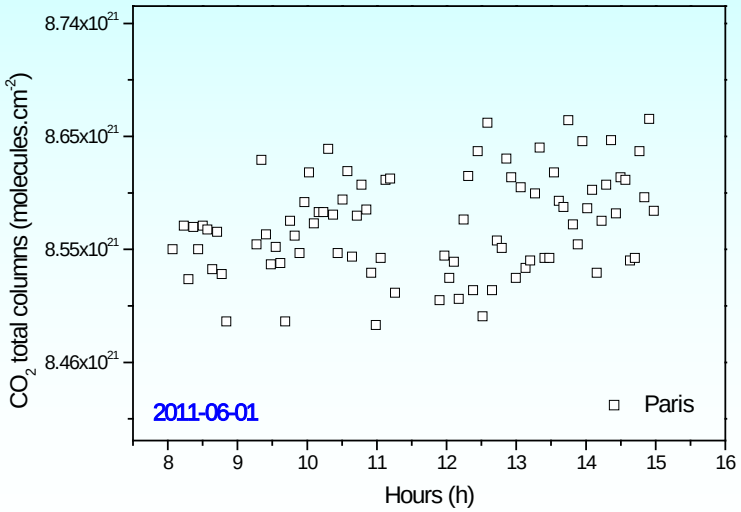


CO_2 total Column (10^{21} molecules.cm^{-2})

- from 3.8 µm => 8.59
- [1.597-1.618 µm] => 8.54
- [1.567-1.587 µm] => 8.51

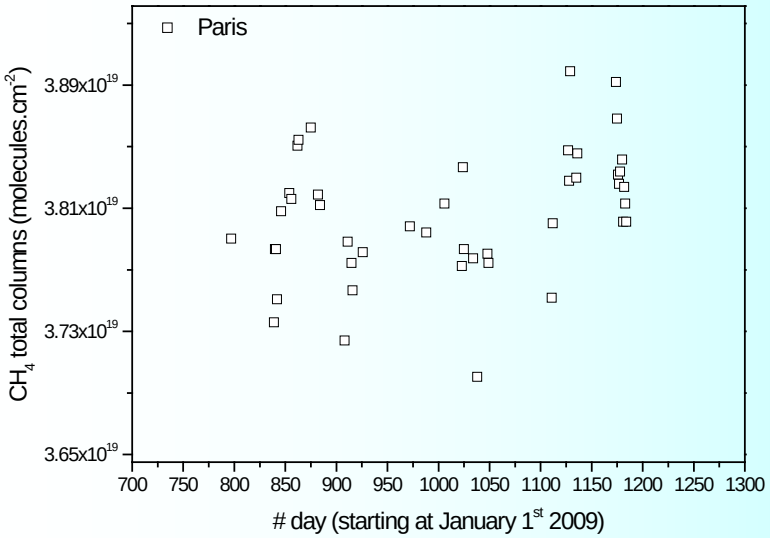
➔ Difference around 1%



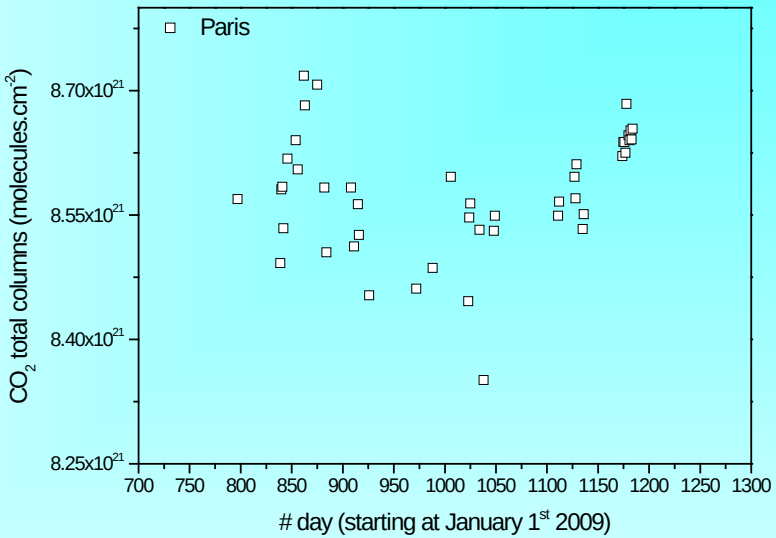


Paris time series data

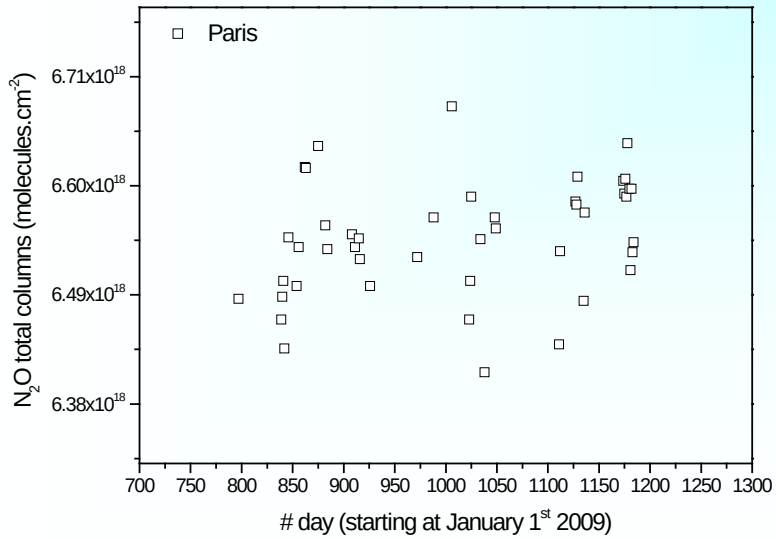
CH_4



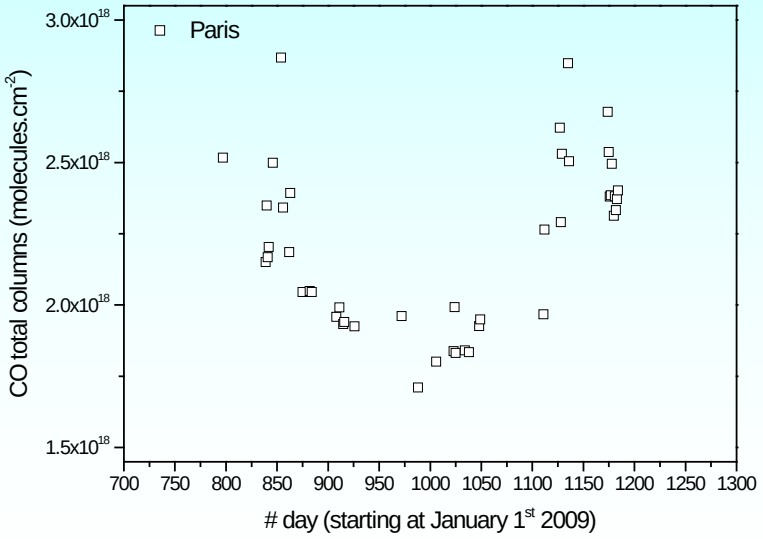
CO_2



N_2O



CO



Preliminary results comparison with the TCCON-Orléans site

TCCON-Orléans at Trainou

https://tccon-wiki.caltech.edu/Sites/Orleans

Urban & rural sites

- In the Orléans forest (rural site) [47.97° N, 2.113°E, 130 m asl]

- InGaAs detector without any optical filter covering the spectral domain from 3900 to 9000 cm^{-1}

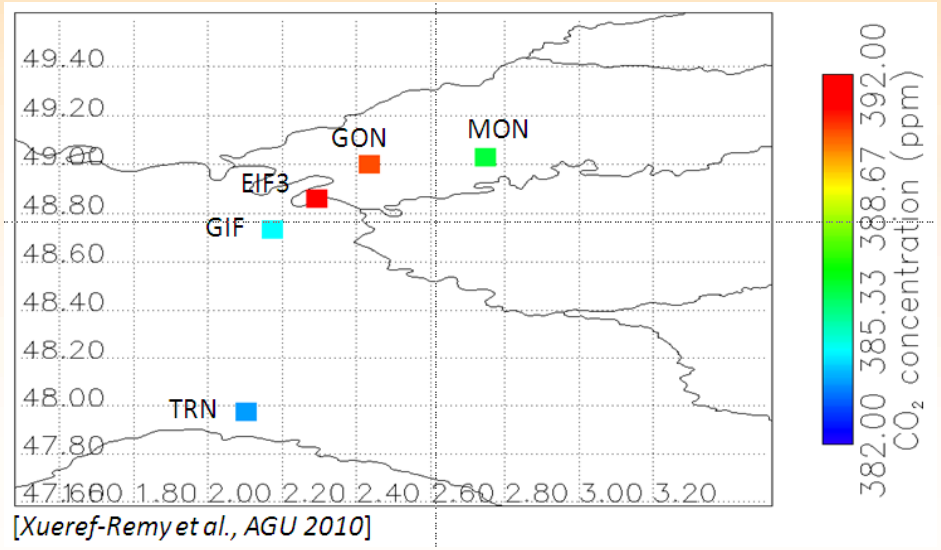
- Retrieval in Near-IR using GFIT

- More than 20000 spectra from August 29th 2009 to October 31st 2011 used to retrieve the concentrations of CO_2, CH_4, N_2O, CO, HF, H_2O, HCl and O_2

- In the downtown of Paris (Megacity) [48.846° N, 2.356°E, 60 m asl]

- InSb detector combined with 3 different optical filters (1850-3200 cm^{-1}, 3800-5200 cm^{-1}, 5500-7200 cm^{-1})

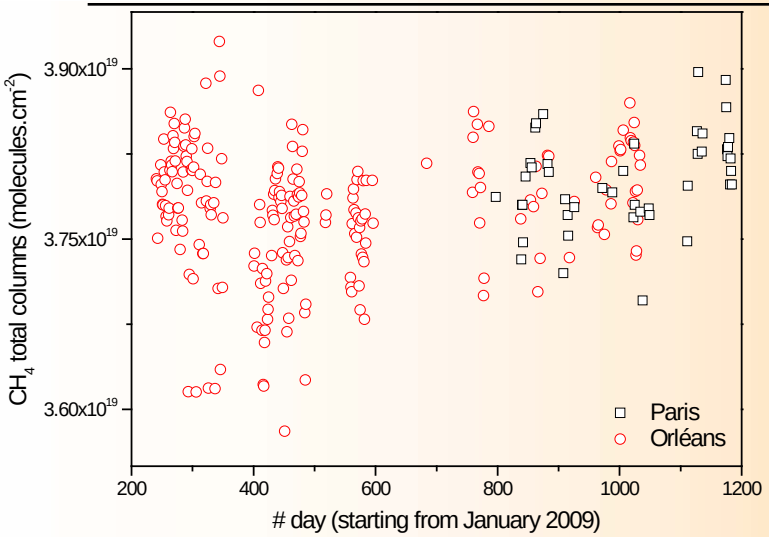
- Retrieval in Mid-IR using PROFFIT



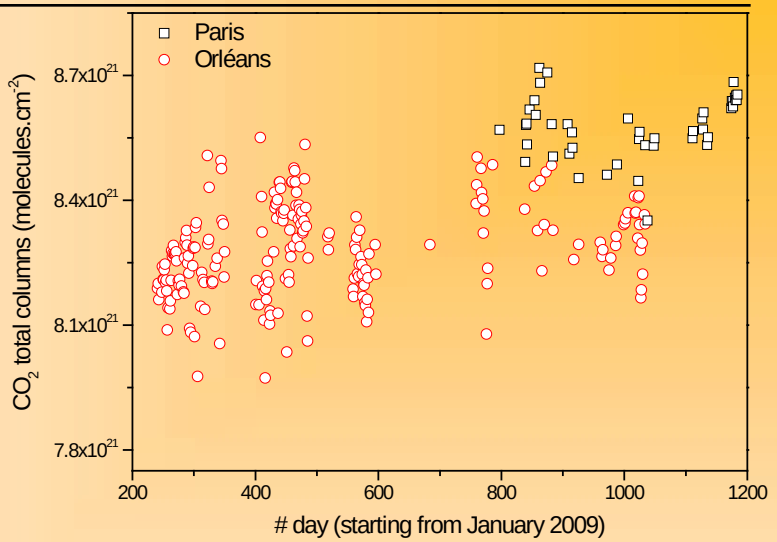
[Xueref-Remy et al., AGU 2010]

Courtesy of I. Xueref-Remy

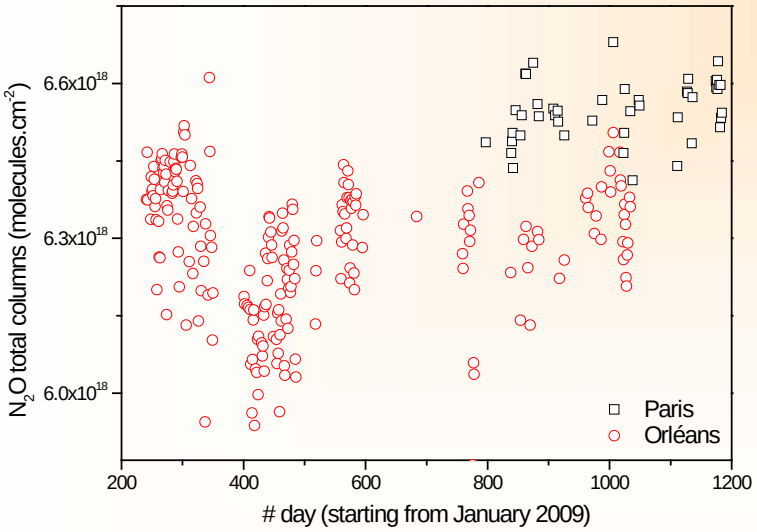
Daily total columns comparison



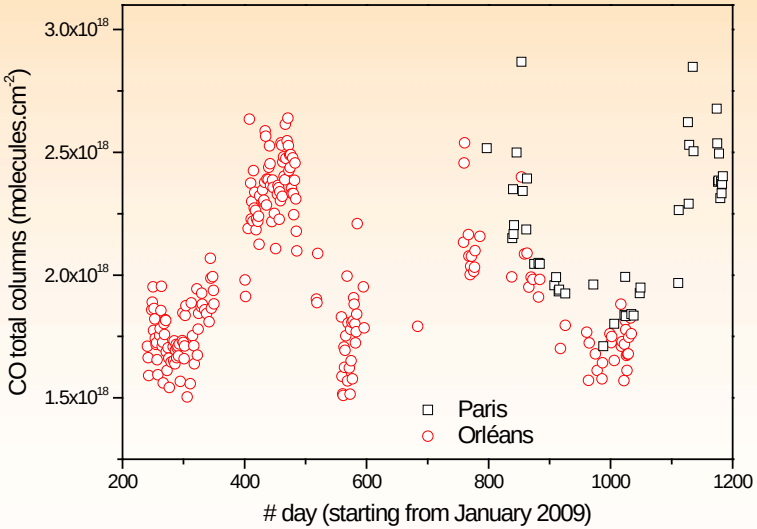
➔ No CH_4 significant difference



➔ Difference between Paris and Orléans ~3%

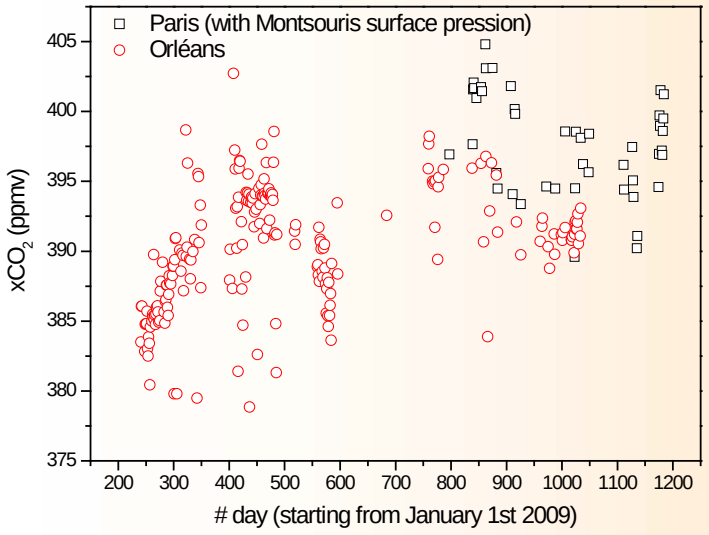


➔ Difference of about 3%



➔ Higher CO peaks at Paris (local emission)

Daily xCO_2 comparison



- xCO_2 = CO_2 column / dry air column

- Surface pressure measured at Orléans
- Surface pressure from NCEP at Paris

➔ Same difference of 3% between Paris and Orléans (as compared as the total columns)

- Surface pressure from Montsouris park (~ 4 km from the QualAir FTS location)

➔ Difference of 2% between Paris & Orléans

Bias sources:

⇒ Spectral intervals difference (spectroscopy)

⇒ Surface pressure measurement

⇒ Instrumental calibration (InGaAs detector and HCl cell)

⇒ Retrieval harmonization (GFIT & PROFFIT)

⇒ Anthropogenic/biogenic contributions

Conclusion and future work

Conclusion and future work

- Description of the QualAir FTS (Paris) & TCCON-Orléans
- GHG retrieved and compared : CO_2, N_2O and CH_4
- Spectral intervals difference in the retrievals (MIR versus NIR)

Preliminary results :

- No significant difference observed between Orléans (rural site) and Paris (urban site)
- Difference of 3% for N_2O (due to spectroscopy ?)
- CO peaks higher in Paris than in Orléans
- Difference of 3% for CO_2
  - → spectroscopy contribution ?
  - → surface pressure contribution ?
  - → instrumental contribution ?

TCCON-Paris : (LEFE project)

- Surface pressure measurement (altitude difference)
- Instrumental characterisation (InGaAs & HCl cell)
- Retrieval characterisation (ILS by LINEFIT, GFIT & PROFFIT)

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Thank you for your attention

cnrs dépasser les frontières

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Sciences de l'environnement

Station QualAir Jussieu