Plume detection and characterization from XCO$_2$ imagery: potential of Gaussian methods for analysing and estimating plant and city fluxes

SPASCIA/LSCE/IPSL
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A new method for point source plume characterization and emission inversion from the atmospheric XCO$_2$ images has been developed and tested:

- Exploiting 2D image information of the plume
- Based on Gaussian modelling of the plume, adapted for single/multiple point sources and for extended sources
- Image preprocessing for the plume characterization (direction, background)
- OEM inversion scheme fitting all Gaussian parameters in the state vector consistently with characterized a priori values and uncertainties. An effective wind speed is derived from ancillary data and used for the emission estimate.

Objective criteria allows the identification of favorable observation cases for the quantification of the emissions: good fit of the Gaussian plume(s), characterization of the plume contrast in the image, OEM convergence and $\chi^2$ criteria. This allows:

- Data filtering and flagging.
- Identification of potential sites that can be monitored by a given mission configuration (applied to the MicroCarb City Mode for the characterization of candidate target sites in support of the mission strategy)

Validation with realistic synthetic XCO$_2$ images provided by CHIMERE simulations (LSCE) for a representative set of city/power plant sites, including: high resolution emission inventories, realistic atmospheric dynamics and boundary conditions, simplified instrumental configuration for MicroCarb City Mode and GeoCarb.
Synthetic datasets and sites selection
Simulations over Western Europe of daily fields of column averaged dry air carbon dioxide mixing ratio ($\text{XCO}_2$) for July 2016

- IER 1 km emission inventories, 8 km VPRM vegetation flux model, 15 km CAMS $\text{XCO}_2$ boundary conditions
- CHIMERE transport model at 2 km resolution (forced by ECMWF meteorological fields at ~ 9 km) to represent realistic atmospheric signatures of the emissions

**XCO$_2$ (ppm) from day 8 to 14**

- Overall $\text{XCO}_2$
- CAMS boundary conditions
- IER anthropogenic emission
- VPRM biogenic fluxes
Pre-selection of European sites covering various typical power plants and cities in France, Belgium, Germany, Great-Britain and the Netherlands, as targets for generating synthetic images: cities (white points and names) and power plants (red points and table).

Sites positions (red points) and numbering (table on the left) for power plants (PP), white points and names (for cities) in the CHIMERE domain (XCO₂ from IER emission only are shown, for the 4th of July 2016 at 12:00).
**CONSIDER A REPRESENTATIVE SET OF SITES (CITIES, PP)**

Selection of 16 sites in the CHIMERE domain

<table>
<thead>
<tr>
<th>Plants</th>
<th>Emission [MtC/yr]</th>
<th>$X_{CO2 \ max}$ [ppmv]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dunkerque</td>
<td>1.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Weisweiler</td>
<td>6.9</td>
<td>5.1</td>
</tr>
<tr>
<td>Niederassem</td>
<td>10.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Duisburg</td>
<td>6.4</td>
<td>4.5</td>
</tr>
<tr>
<td>Völklingen</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Karlsruhe</td>
<td>1.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Großkrotzenburg</td>
<td>1.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Amer</td>
<td>1.6</td>
<td>1.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cities</th>
<th>Emission [MtC/yr]</th>
<th>$X_{CO2 \ max}$ [ppmv]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paris</td>
<td>12.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Rotterdam</td>
<td>11.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Anvers</td>
<td>3.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Strasbourg</td>
<td>0.9</td>
<td>0.60</td>
</tr>
<tr>
<td>Mulhouse</td>
<td>0.62</td>
<td>0.70</td>
</tr>
<tr>
<td>Bonn</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Lille</td>
<td>0.97</td>
<td>0.40</td>
</tr>
<tr>
<td>Le Mans</td>
<td>0.37</td>
<td>0.35</td>
</tr>
</tbody>
</table>

*List of 8 power plants (upper table) and 8 cities (lower table) selected as representative of different types of source configurations in terms of plume and emission intensity and of site extension and isolation. ($X_{CO2 \ max}$: monthly mean value of maximum concentration of the plume).*
Method
**METHODOLOGY: GAUSSIAN PLUME MODELLING**

- **Plume: reformulation of the classic (e.g., Bovensmann et al., 2010) Gaussian model**

\[
\Delta \text{XCO}_2(x, y) = \text{XCO}_2(x, y)_{\text{plume}} - \text{XCO}_2(x, y)_{\text{background}} = C_0 \frac{\sigma_0}{\sigma_y(x)} e^{-\frac{1}{2} \left( \frac{y}{\sigma_y(x)} \right)^2}
\]

expressed in the plume coordinates system xOy, Ox is the direction of the plume axis, Oy the direction perpendicular to the plume axis. For \( x > 0 \), the plume spreads in the transverse direction Oy, as:

\[
\sigma_y(x) = \sigma_0 \left( \frac{x}{x_0} \right)^b
\]

with \( C_0 = \text{Coeff} \frac{F}{\sqrt{2\pi} \sigma_0 U} \) and \( x_0 = \left( \frac{\sigma_0}{a} \right)^{1/b} \)

- XCO\(_2\) is the CO\(_2\) dry air column averaged mole fraction in ppmv (integrated over any single image pixel)
- **4 control parameters:** \( C_0 = f(F, U), \sigma_0, x_0, b \)
  - \( C_0 = \text{Coeff} \frac{F}{\sqrt{2\pi} \sigma_0 U} \) in ppmv. \( \text{Coeff} = \frac{M_{\text{mol}} \text{air} \cdot g(x, y)}{M_{\text{mol}} \text{CO}_2 F_3(x, y)} \): F : flux in gCO\(_2\)/s; U : wind component in the x direction, in m/s
  - \( \sigma_0 \) : plume spread in the y direction at \( x = x_0 \), in km; \( a \) : parameter characterizing the plume width
  - \( x_0 \) : offset distance in the x direction (avoid singularity in \( x=0 \)), in km
  - \( b \) : parameter characterizing the plume dynamics or transverse plume widening

- **Background CO\(_2\) field, in the image coordinate system XOY** (rotation of angle \( \Phi_0 \) of the plume axis)

\[
\text{XCO}_2(X, Y)_{\text{background}} = \text{XCO}_2(0, 0) + X \ p_X + Y \ p_Y
\]

- **3 control parameters** for the background: \( \text{XCO}_2(0, 0), p_X, p_Y \)
- **1 parameter** for the plume direction, \( \Phi_0 \) : plume direction angle in the XOY reference system
OEM retrieval scheme adjusting the 8 parameters of the Gaussian model from noisy pseudo-observations (1 ppm error stdv)

A preprocessing is implemented for the image analysis: detecting the presence of one (or several) plume(s), characterizing the plume (extension, amplitude, source position), and providing a first estimate of background and direction parameters.

Fitting 8 parameters:
- background and wind direction well constrained.
- More than 2 pieces of information (over 4) on Gaussian model parameters.
- $C_0$ (proportional to $F/U$) is constrained by the data.
Results: Plume Characterization

- Validation with MicroCarb City Mode simulations: processing of 180 noisy images (6 sites x 30 days). How does the Gaussian model fit realistic observations?

Identify cases well-fitted with our Gaussian retrieval:

$$\chi^2_{y \text{ (red)}} = \frac{(y_{\text{obs}} - y_{\text{OEM}})^T S_y^{-1} (y_{\text{obs}} - y_{\text{OEM}})}{N_{\text{obs}}}$$

close to 1 (threshold: 1.15)

Weisweiler (strong source: ~ 19 Mt CO$_2$/year)
73 % of favorable cases

Rodenhuis (weaker source: ~ 5 Mt CO$_2$/year)
50 % of favorable cases

Over the 6 sites and 30 days, 60 % of cases are identified as favorable:

- Well fitted
- Detectable (good SNR)
- Retrieval convergence and stability with noise

(1 ppm noise, no clouds)
From gaussian parameters to source emission retrieval (F): exploiting wind information for determining $U$

- Point source emission $F$ is estimated from $C_0$ and given an « effective » wind $U = U_{\text{eff}}$
  - $U_{\text{eff}}$ is estimated from the ECMWF wind profile, plus some rule to choose the wind effectively acting on the CO$_2$ plume: $U_{\text{eff}}$ is taken as a combination of the 3 estimators below
    - Wind at the altitude of the source
    - Wind averaged in the mixed boundary layer
    - Wind with the closest direction to the plume direction

- ECMWF wind profile: 12:00 analysis, 137 levels, 0.125 ° resolution. Boundary layer height available
**RESULTS: EMISSION RETRIEVAL**

Test for Weisweiler, from days 1 to 7, MicroCarb configuration

Site emission $F$ (ton of C per hour) and error are computed using different hypotheses of \textit{a priori} constraint on gaussian parameters (SC1, SC2 and SC3 approaches), and given an « effective » wind $U = U_{\text{eff}}$

Retrieved $F$ is compared with hourly site emission prescribed in CHIMERE simulation.
Necessity to deal with multiple and extended sources for addressing realistic scenes
Duisburg, 12/07/16: MicroCarb configuration

TRUE

RETRIEVAL

3 sources must be considered to reproduce correctly the CHIMERE image with the Gaussian model. The consideration of 3 sources improves only slightly the flux retrieval bias of the central source (if considered isolated). However, the residual in the observation space ($\chi^2$) is significantly reduced, improving the quality of the image retrieval.
A surfacic source (disk of radius $R$) is considered for properly reproducing the Paris plume with the Gaussian model.

The consideration of a surfacic source significantly improves the flux retrieval. The proper adjustment of the size of the source (radius) is critical and allows a good retrieval of the flux, not possible if only a point source is considered.
Results: Power plants
**RESULTS: plume inversion**

**Example of MicroCarb synthetic images over Niederaussem, 6th and 22th July 2016 at 12:00**

Image: 20 x 20 pixels (40 km x 40 km), with a 2 km x 2 km pixel

Multiple sources considered for this retrieval

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**06/07/16**: Good fit of the image and good flux retrieval

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**22/07/16**: Complex scene, bad fit of the image and incorrect flux retrieval, but well identified case, flagged through the quality check (large $\chi^2$)
RESULTS: PLUME INVERSION

TRUE

06/07/16: Proper fit of the image and good flux retrieval, but flag resulting from a "parasitic" plume (source(s) on the left of the domain)

OBS

Example of GEO like synthetic images over Niederaussem, 6th and 22th July 2016 at 12:00

RETRIEVAL

Image: 14 x 14 pixels (84 km x 84 km), with a 6 km x 6 km pixel

Multiple sources considered for this retrieval

22/07/16: Complex scene, bad fit of the image and improper flux retrieval, but well identified case, flagged through quality check (large $\chi^2$)
Point source emission retrieval: test for Niederaussem, from days 1 to 30: MicroCarb and GEO like configurations

**MicroCarb**

In MicroCarb mode: background parameters $XCO_2(0,0), p_x, p_y$; wind direction $\Phi_0$, atmospheric dispersion parameter $\sigma_0$, and flux $F$ are constrained by the retrieval (SC2 scenario). In GEO mode, exploiting external information (e.g., Pasquill classification) to constrain the Gaussian parameter $\sigma_0$ is necessary (SC3 scenario).

- Larger number of good retrievals in the MicroCarb mode (less days flagged), larger uncertainties on individual retrievals in GEO mode.
- In terms of monthly averaged flux: better performances for MicroCarb mode (1% bias, 5% noise). The retrieved values are consistent with CHIMERE reference flux in both cases.

MicroCarb/Geo mode differences, in terms of retrieval values and error, would be mainly due to the image resolution (i.e., number of pixels effectively capturing the plume and gradient information, capability to capture multiple point sources).
Plant emission retrieval: results on several sites

In MicroCarb mode: good performances for most of the sites, including “relatively small” plants like Dunkerque or Karlsruhe (averaged DOFS > 0.5). Error from 5% (large plants) to 10-25% (small plants) on monthly averaged flux retrieval.

<table>
<thead>
<tr>
<th>Site</th>
<th>type</th>
<th>#</th>
<th>Scenario</th>
<th>Reference Flux [tC/h]</th>
<th>Retrieved Flux [tC/h]</th>
<th>Error [tC/h]</th>
<th>Error [%]</th>
<th>DOFS mean</th>
<th>χ² mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dunkerque</td>
<td>plant</td>
<td>1</td>
<td>SC2</td>
<td>150</td>
<td>148</td>
<td>24</td>
<td>16</td>
<td>0.58</td>
<td>1.00</td>
</tr>
<tr>
<td>Weisweiler</td>
<td>plant</td>
<td>2</td>
<td>SC2</td>
<td>690</td>
<td>662</td>
<td>35</td>
<td>5</td>
<td>0.79</td>
<td>1.16</td>
</tr>
<tr>
<td>Duisburg</td>
<td>plant</td>
<td>3</td>
<td>SC2</td>
<td>552</td>
<td>542</td>
<td>32</td>
<td>6</td>
<td>0.70</td>
<td>0.99</td>
</tr>
<tr>
<td>Niederaussem</td>
<td>plant</td>
<td>4</td>
<td>SC2</td>
<td>575</td>
<td>581</td>
<td>29</td>
<td>5</td>
<td>0.93</td>
<td>1.06</td>
</tr>
<tr>
<td>Karlsruhe</td>
<td>plant</td>
<td>6</td>
<td>SC2</td>
<td>91</td>
<td>79</td>
<td>18</td>
<td>23</td>
<td>0.62</td>
<td>0.99</td>
</tr>
<tr>
<td>Amer</td>
<td>plant</td>
<td>8</td>
<td>SC2</td>
<td>195</td>
<td>199</td>
<td>23</td>
<td>11</td>
<td>0.70</td>
<td>1.00</td>
</tr>
</tbody>
</table>

In GEO-like mode: degraded performances for “relatively small” plants, but good results for the largest plants, with errors from 8 to 15% on monthly averaged flux retrieval.

<table>
<thead>
<tr>
<th>Site</th>
<th>type</th>
<th>#</th>
<th>Scenario</th>
<th>Reference Flux [tC/h]</th>
<th>Retrieved Flux [tC/h]</th>
<th>Error [tC/h]</th>
<th>Error [%]</th>
<th>DOFS mean</th>
<th>χ² mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dunkerque</td>
<td>plant</td>
<td>1</td>
<td>SC3</td>
<td>150</td>
<td>152</td>
<td>75</td>
<td>49</td>
<td>0.19</td>
<td>0.95</td>
</tr>
<tr>
<td>Weisweiler</td>
<td>plant</td>
<td>2</td>
<td>SC3</td>
<td>693</td>
<td>718</td>
<td>58</td>
<td>8</td>
<td>0.77</td>
<td>1.06</td>
</tr>
<tr>
<td>Duisburg</td>
<td>plant</td>
<td>3</td>
<td>SC3</td>
<td>546</td>
<td>581</td>
<td>85</td>
<td>15</td>
<td>0.62</td>
<td>1.05</td>
</tr>
<tr>
<td>Niederaussem</td>
<td>plant</td>
<td>4</td>
<td>SC3</td>
<td>579</td>
<td>517</td>
<td>78</td>
<td>15</td>
<td>0.73</td>
<td>1.18</td>
</tr>
<tr>
<td>Karlsruhe</td>
<td>plant</td>
<td>6</td>
<td>SC3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amer</td>
<td>plant</td>
<td>8</td>
<td>SC3</td>
<td>192</td>
<td>233</td>
<td>52</td>
<td>22</td>
<td>0.34</td>
<td>1.03</td>
</tr>
</tbody>
</table>
Results : City
RESULTS: CITY PLUME INVERSION

Example of MicroCarb synthetic images over Paris, 3rd and 12th July 2016 at 12:00

Image: 20 x 20 pixels (40 km x 40 km), with a 2 km x 2 km pixel
Extended source is considered

**TRUE**

03/07/16: High DOFS, good fit of the image and correct flux retrieval

**OBS**

**RETRIEVAL**

12/07/16: High DOFS, correct fit of the image, overestimation of the flux despite a retrieved plume with low intensity: suggest some bias in effective wind estimate (retrieved plume with a larger spread and of lower intensity than the truth)
**RESULTS: CITY PLUME INVERSION**

**FIRST GUESS**

**TRUE**

**RETRIEVAL**

**06/07/16**: Case of low wind, correct fit of the image and proper flux retrieval

Example of GEO-like synthetic images over Paris, 6th and 9th July 2016 at 12:00

Image: 18 x 18 pixels (108 km x 108 km), with a 6 km x 6 km pixel

Extended source is considered for this retrieval

**09/07/16**: Correct fit of the image and proper flux retrieval, due to a good retrieval of $\sigma_0$

Point source emission retrieval: test for Paris, from days 1 to 7

MicroCarb and Geo-like configurations

In both MicroCarb and GEO mode: background parameters $XCO_2(0,0), p_X, p_Y$; wind direction $\Phi_0$, atmospheric dispersion parameter $\sigma_0$, and flux $F$ are constrained by the retrieval (SC2 scenario).

- Good performances in both modes: slightly larger number of good retrievals in the MicroCarb mode, slightly better accuracy on individual retrievals in the GEO mode.
- In terms of monthly averaged flux: better performances for the GEO mode (no bias, 9% noise). The retrieved values are consistent with the CHIMERE reference flux in both cases.

MicroCarb/GEO-like differences: MicroCarb mode is usable over Paris city (error 12%), despite a limited image size, because of the good image resolution; good results are obtained in the GEO mode (error 9%) due to the image size which capture the whole panache and surrounding background.
City emission retrieval: Results on several sites

In MicroCarb mode: good performances for Paris (12 % error on monthly averaged flux retrieval), limited performances for the other (smaller) cities (from 22 to 39 % error). Atmospheric dispersion parameter $\sigma_0$ is not retrieved except for Paris.

<table>
<thead>
<tr>
<th>Site</th>
<th>type</th>
<th>#</th>
<th>Scenario</th>
<th>Reference Flux [tC/h]</th>
<th>Retrieved Flux [tC/h]</th>
<th>Error [tC/h]</th>
<th>Error [%]</th>
<th>DOFS mean</th>
<th>$\chi^2$ mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paris</td>
<td>city</td>
<td>1</td>
<td>SC2</td>
<td>1713</td>
<td>1627</td>
<td>202</td>
<td>12</td>
<td>0.78</td>
<td>1.00</td>
</tr>
<tr>
<td>Anvers</td>
<td>city</td>
<td>3</td>
<td>SC3</td>
<td>420</td>
<td>272</td>
<td>106</td>
<td>39</td>
<td>1.4/4</td>
<td>0.98</td>
</tr>
<tr>
<td>Mulhouse</td>
<td>city</td>
<td>5</td>
<td>SC3</td>
<td>71</td>
<td>76</td>
<td>17</td>
<td>22</td>
<td>0.42</td>
<td>1.00</td>
</tr>
<tr>
<td>Lille</td>
<td>city</td>
<td>7</td>
<td>SC3</td>
<td>111</td>
<td>101</td>
<td>33</td>
<td>33</td>
<td>0.39</td>
<td>0.98</td>
</tr>
<tr>
<td>Le Mans</td>
<td>city</td>
<td>8</td>
<td>SC3</td>
<td>42</td>
<td>46</td>
<td>11</td>
<td>24</td>
<td>0.54</td>
<td>0.99</td>
</tr>
</tbody>
</table>

In GEO-like mode: retrieval done only for Paris, other sites very complex in GEO mode. Good performances over Paris (9% errors) related to the capability of GEO mode to capture the whole plume.

<table>
<thead>
<tr>
<th>Site</th>
<th>type</th>
<th>#</th>
<th>Scenario</th>
<th>Reference Flux [tC/h]</th>
<th>Retrieved Flux [tC/h]</th>
<th>Error [tC/h]</th>
<th>Error [%]</th>
<th>DOFS mean</th>
<th>$\chi^2$ mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paris</td>
<td>city</td>
<td>1</td>
<td>SC2</td>
<td>1702</td>
<td>1704</td>
<td>161</td>
<td>9</td>
<td>0.63</td>
<td>1.00</td>
</tr>
</tbody>
</table>
A complete retrieval scheme based on flexible Gaussian plume modelling and Optimal Estimation Method has been implemented and applied over a representative set of realistic synthetic XCO$_2$ images used for flux retrieval.

In the tested observation modes (MicroCarb and GEO-like, with 1 ppm noise on the XCO$_2$ L2 product), our results suggest that anthropogenic emissions from large power plants ($>4$ MtC/year) and cities ($>10$ MtC/year) should be retrieved, in terms of averaged flux (over month, season or year):

- with 5-20% accuracy for power plants, and with 12% accuracy for Paris city, in the MicroCarb observation mode
- with 10-50% accuracy for power plants, and with 9% accuracy for Paris city, in a GEO-like observation mode

The proposed Gaussian method, allowing flexibility for fitting the plume pattern, intensity and direction, and providing quality criteria for data filtering, appears suitable for XCO$_2$ image processing. Necessary improvements are:

- Proper estimation of the effective wind from ancillary information for unbiased retrieval
- Image preprocessing for scene analysis, plume detection and characterization of wind direction
- Better characterization of error sources related to non Gaussian plume behaviour (turbulence)
Impact of clouds
Test on power plant: site Weisweiler, day 6

Cloud free

10% cloudy

30% cloudy

50% cloudy
Test on power plant: site Weisweiler

Cloud free

- CHIMERE input flux
- CHIMERE mean input flux (around retrievals) = 696 Tc/h
- Mean reliable retrieved flux = 666 ± 33 Tc/h
- Retrieved flux, SC2

10% cloudy

- CHIMERE input flux
- CHIMERE mean input flux (around retrievals) = 694 Tc/h
- Mean reliable retrieved flux = 657 ± 36 Tc/h
- Retrieved flux, SC2

30% cloudy

- CHIMERE input flux
- CHIMERE mean input flux (around retrievals) = 696 Tc/h
- Mean reliable retrieved flux = 677 ± 38 Tc/h
- Retrieved flux, SC2

50% cloudy

- CHIMERE input flux
- CHIMERE mean input flux (around retrievals) = 696 Tc/h
- Mean reliable retrieved flux = 644 ± 44 Tc/h
- Retrieved flux, SC2
Test on city: site Paris, day 9

Cloud free | 10% cloudy | 30% cloudy | 50% cloudy
Test on city: site Paris

Site Paris

**Cloud free**
- CHIMERE input flux
- CHIMERE mean input flux (around retrievals) = 1707 Tc/h
- mean reliable retrieved flux = 1587 ± 203 Tc/h
- Retrieved flux, SC2

**10% cloudy**
- CHIMERE input flux
- CHIMERE mean input flux (around retrievals) = 1707 Tc/h
- mean reliable retrieved flux = 1589 ± 211 Tc/h
- Retrieved flux, SC2

**30% cloudy**
- CHIMERE input flux
- CHIMERE mean input flux (around retrievals) = 1707 Tc/h
- mean reliable retrieved flux = 1575 ± 228 Tc/h
- Retrieved flux, SC2

**50% cloudy**
- CHIMERE input flux
- CHIMERE mean input flux (around retrievals) = 1707 Tc/h
- mean reliable retrieved flux = 1581 ± 256 Tc/h
- Retrieved flux, SC2
Preliminary test with cloud fraction randomly applied on the images suggests that flux retrieval could be robust to the impact of clouds up to 30% cloud fraction.

Next steps:
- Method and processing improvement (see previous slides)
- Applying on different scenarios of cities
- Test on real data: OCO-3, Sentinel 5P
- More realistic cloud disturbances of the XCO₂ images
Thank you for your attention

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Olivier.Lezeaux@spascia.fr

Related presentations, Session 7, Wednesday June 5 :

GeoCarb, B. Moore
MicroCarb project, F. Buisson
MicroCarb L1&L2 products, D. Jouglet

Session 1
OCO-3, A. Eldering
Additional slides
Project objectives

Point source emission retrieval: test for Paris, from days 1 to 7

(1/2) : MicroCarb configurations

**MicroCarb**

**Site Paris**

- CHIMERE input flux
- CHIMERE mean input flux (period of 2 hours before the overpass time) = 1713 tC/h
- Mean retrieved flux (weighted average for successful retrievals) = 1627 +/- 202 tC/h
- Retrieved flux, SC2

![Graph showing point source emission retrieval data for Paris](image-url)
Project objectives

Point source emission retrieval: test for Paris, from days 1 to 7 (2/2) : Geo-like configurations

Geo-like

Site Paris

CHIMERE input flux

CHIMERE mean input flux (period of 2 hours before the overpass time) = 1702 tC/h

Mean retrieved flux (weighted average for successful retrievals) = 1704 +/- 161 tC/h

Retrieved flux, SC2