Requirements for the high resolution satellite imagery of atmospheric GHG in view to monitor the emissions from large cities

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LOGOFLUX I & II (ESA) and BridGES partners
High Resolution imagery for monitoring GHG city emissions

- Political need for **improving / verifying** the estimate of **emissions from cities**
- Increasing number of **city scale in situ CO2 measurement networks**:
  - difficulties to deal with **local signals**, to get integrated views of city plumes
  - **political issues** for setting-up in situ networks dedicated to verification
- Plans for **HR imagery of XCO2/XCH4**: Carbonsat (2 km / ~5 days) & propositions for XCO2 with Sentinel-5 (8 km / ~1 day)
  - Study of its potential for quantifying emissions of large cities: **tests for Paris**
Modelling the Paris CO2 plume seen from space

- Paris = “easy” case (dense city remote from other large urban areas, flat topography)
- The signature of 1-hour emissions vanishes from the XCO2 image in ~5-6 hours

Annual Fossil Fuel emissions in the Paris area (total ~ 15MtC; AIRPARIF)

XCO2 spatial variations in the modeling domain on Oct 6 2010 at 11:00

Simulation at 2km res without measurement error
CarbonSat obs with 1.1 ppm measurement noise
4km imagery with 1.2 ppm measurement noise
Results for CO2 with an optimistic configuration

- Use individual images at 11:00 to retrieve the emissions 6 hours before
- 20 test cases (20 days in Oct): dependence of the results to the wind speed
- Ignore transport errors, clouds, systematic errors
- 20-70% uncertainty reduction for 6-hour emissions with Csat, potential to solve for temporal profiles, dependence to space res and meas error

*Posterior uncertainty in hourly and 6-hour mean emissions*
Cloud cover and systematic errors for CarbonSat XCO2

- Using 1-year simulations by IUP Bremen
  ➢ only 19 useable images. Need for other data to derive daily to annual budgets. Ability to monitor trends?
  ➢ smaller uncertainty reduction and large biases in fluxes. Solving for systematic errors: a critical challenge. Complementarity with ground based networks?

Random uncertainty reduction when accounting for cloud cover without and with systematic errors

Posterior biases when including syst errors
Inversion of the CH4 emissions using CarbonSat XCH4

- Only landfills can be monitored?
- Large biases when including systematic errors

> Cities: good test cases for CH4? Need to focus on larger sources (e.g. gas extraction)?

Uncertainties with 9 ppb meas noise only, and bias with syst errors