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The potential of satellite spectro-imagery for monitoring CO_2 emissions from large cities

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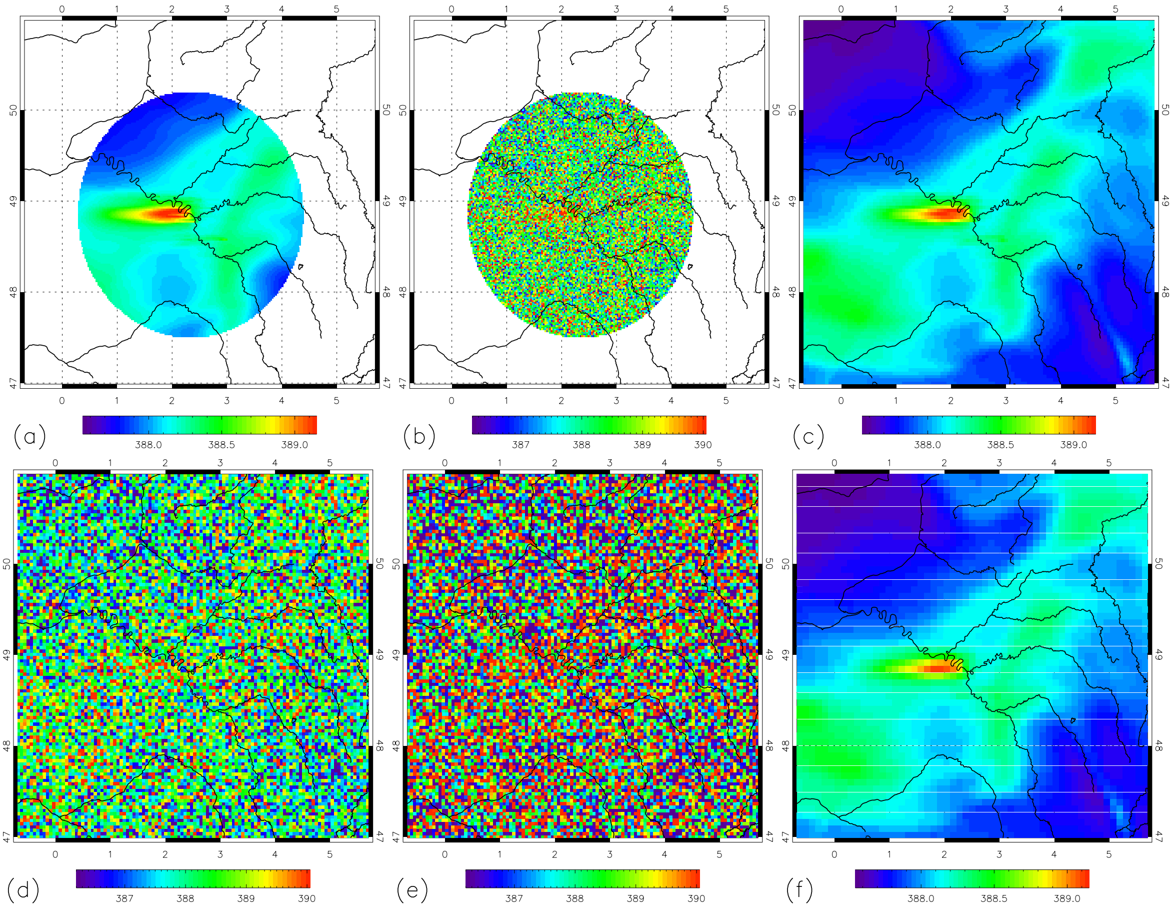

Figure S1. Simulation of XCO_2 (in ppm) as seen from space over the CHIMERE domain used in this study, on October 7th 2010 at 11:00 and using the operator described in section 2.5, the flux budgets given by Airparif and C-TESSEL and the model initial and boundary conditions given the global LMDZ simulation. a) Simulation at 2 km resolution with the sampling corresponding to TH-CarbonSat ignoring the observation errors. b) Perturbation of (a) using a 1.1 ppm noise (i.e., the CS theoretical measurement error). c) Simulation at 4 km resolution corresponding to the 4 km resolution TH-LargeSwath sampling ignoring the observation errors. d) Perturbation of (c) using a 1.2 ppm noise (i.e., the Sent5-2 SWIR theoretical measurement error). e) Perturbation of (c) using a 2.1 ppm noise (i.e., the Sent5-1 SWIR theoretical measurement error). c) Simulation at 8 km resolution corresponding to the 8 km resolution TH-LargeSwath sampling ignoring the observation errors. The longitudes and latitudes of the domain are indicated in degrees East and North.

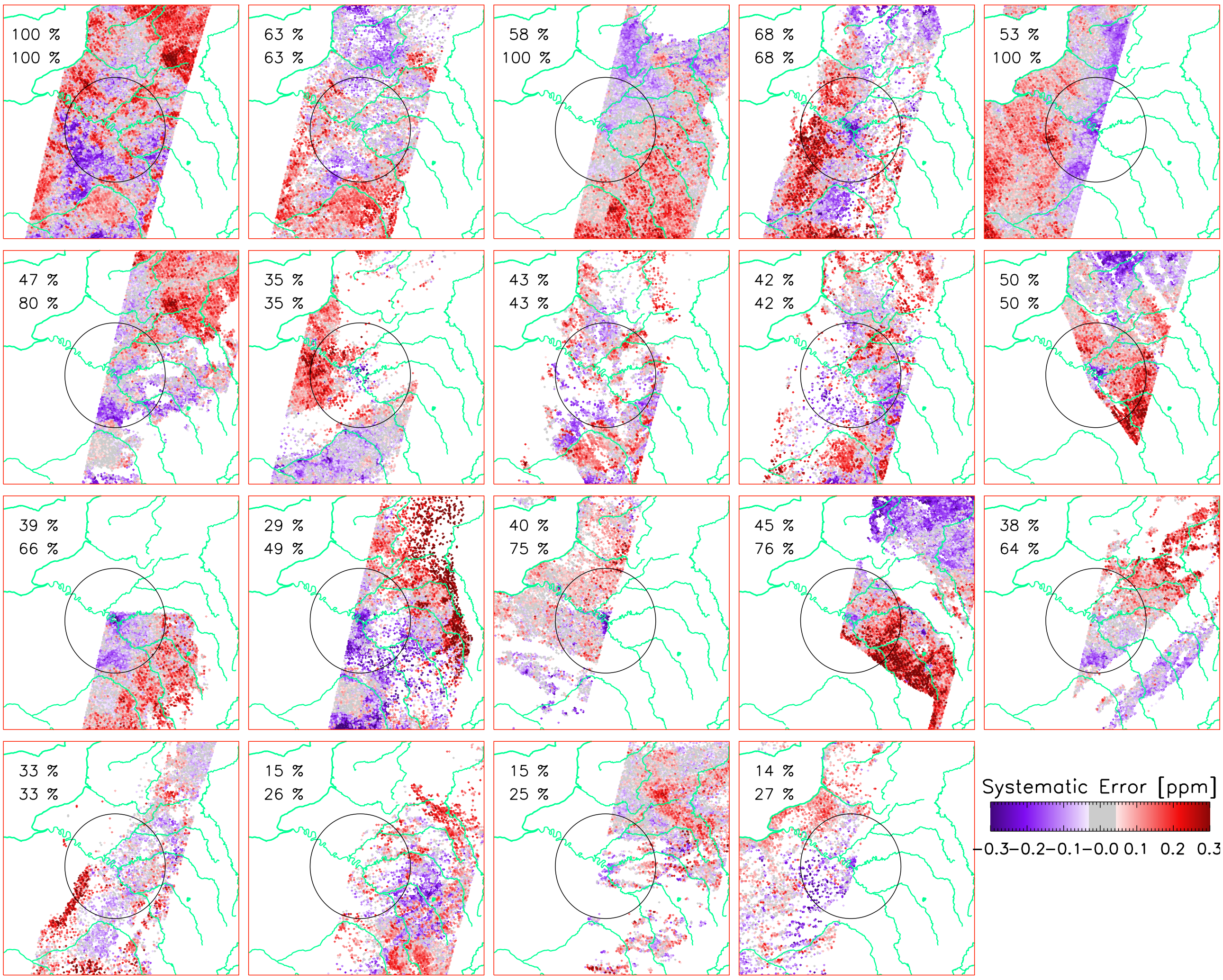

Figure S2. The 19 240 km-swath passes over the Paris area which provide the most observations within a distance of 100 km from the centre of Paris out of 1-year of simulation of the CarbonSat sampling over the globe by Buchwitz et al. (2013) and the associated systematic errors. The 100 km radius circle centred on Paris is drawn in black. These passes approximately correspond to the 19 "SIM-CarbonSat" best observation samplings for a given inversion day that are defined based on scores of theoretical uncertainty reductions. Numbers provided on the top left of each subfigure: percentage of the area within a distance of 100 km from the centre of Paris sampled by the cloud free pixels (top) and percentage of the area within the satellite swath and within a distance of 100 km from the centre of Paris sampled by the cloud free pixels (bottom).

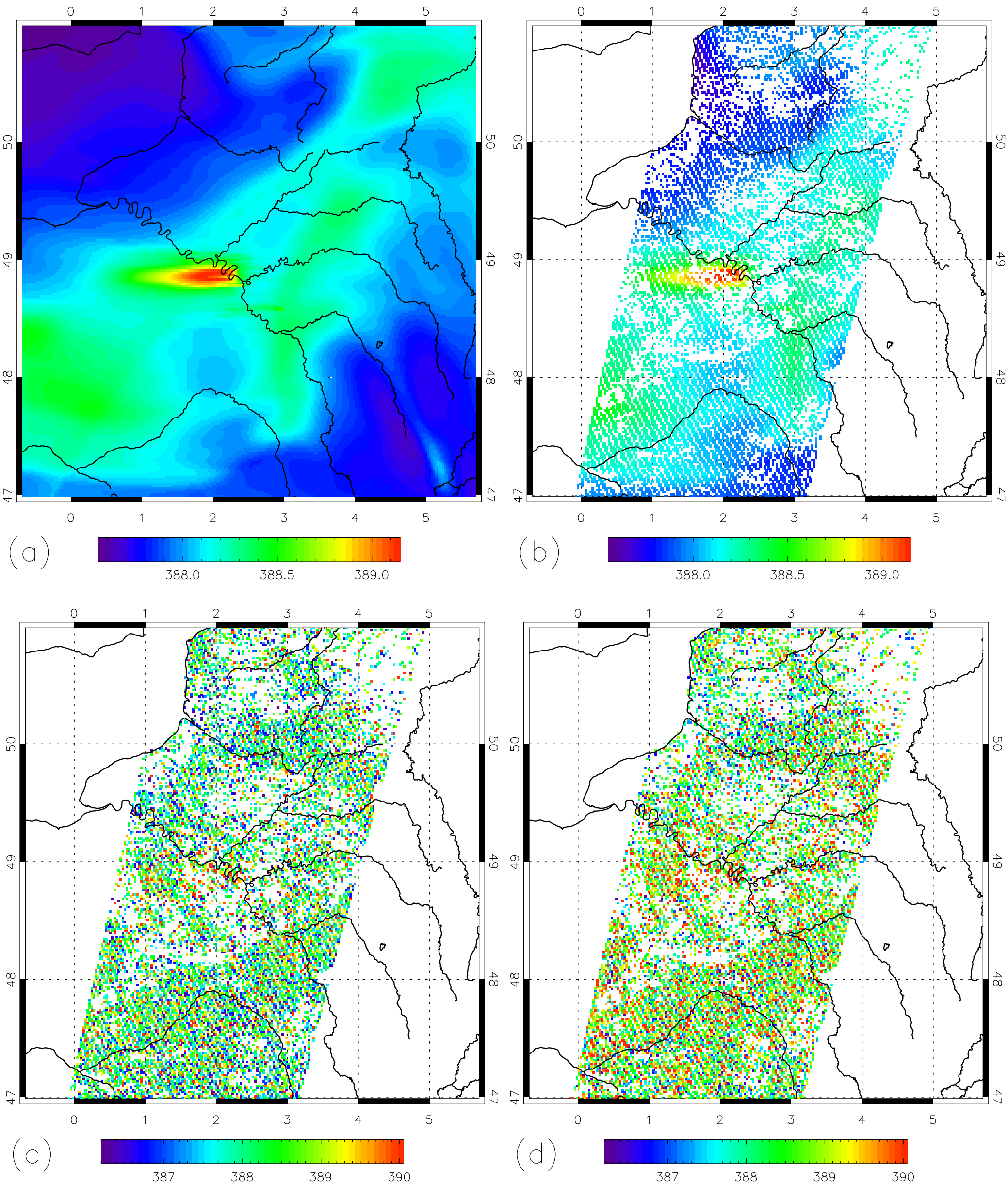

Figure S3. Simulation of XCO_2 (in ppm) as seen from space over the CHIMERE domain used in this study, on October 7th 2010 at 11:00 and at 2 km resolution using the operator described in section 2.5, the flux budgets given by Airparif and C-TESSEL and the model initial and boundary conditions given the global LMDZ simulation. a) Simulation ignoring the limitation of the satellite field of view, the cloud cover and the observation errors (same as figure 1). b) Sampling of (a) corresponding to the second observation sampling of CarbonSat simulated by Buchwitz et al. (2013) shown in figure S2. c) Perturbation of (b) using a map of samples of the random errors corresponding to this observation sampling in the simulation by Buchwitz et al. (2013). d) Perturbation of (c) using the map of systematic errors corresponding to this observation sampling in the simulation by Buchwitz et al. (2013). The longitudes and latitudes of the domain are indicated in degrees East and North.

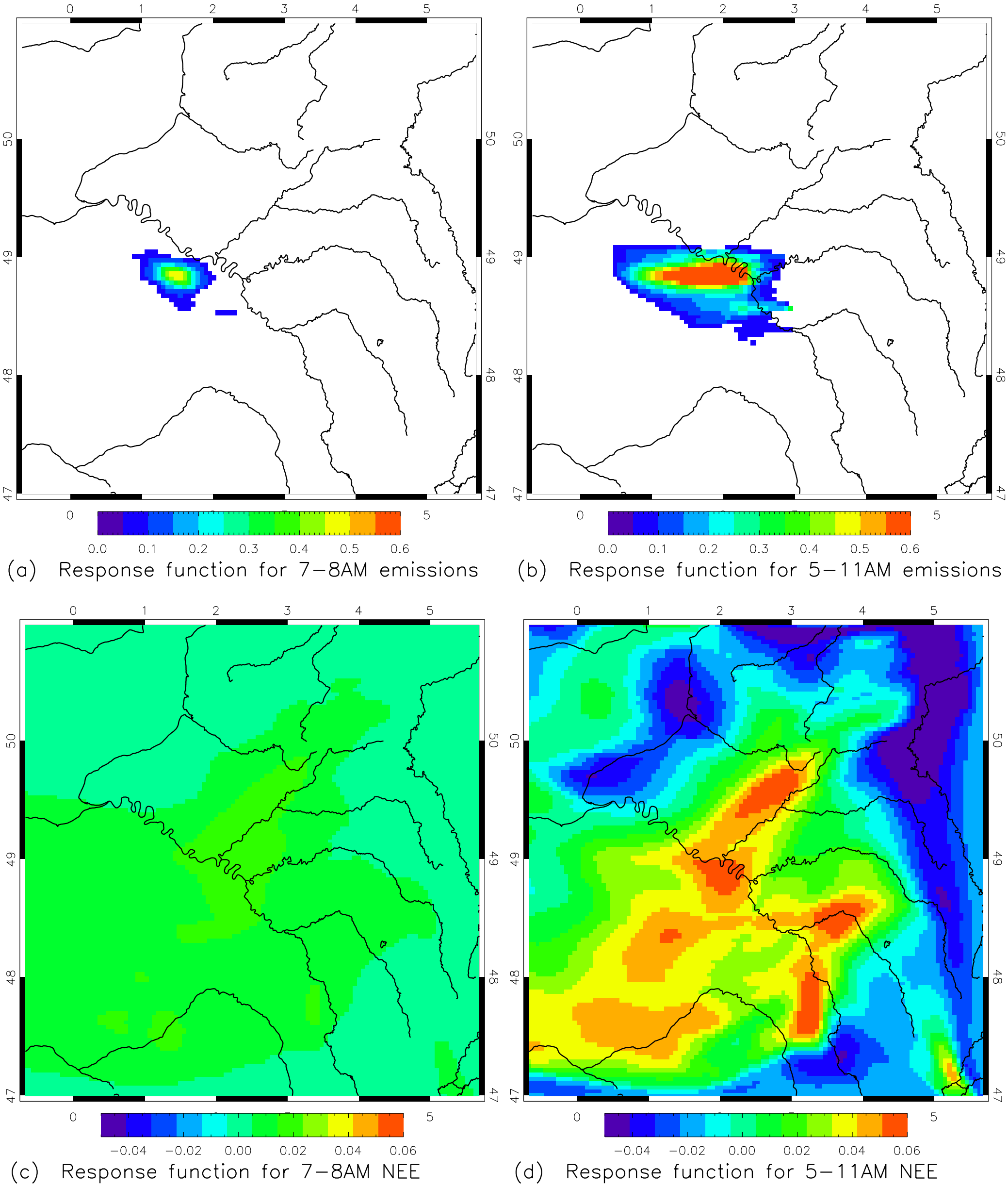

Figure S4. Simulation of the XCO_2 response functions of different flux components (in ppm) as seen from space over the CHIMERE domain used in this study, on October 7th 2010 at 11:00 and at 2 km resolution using the operator described in section 2.5, the computations described in section 2.5.4, and the flux budgets given by Airparif or C-TESSEL. a) Response function for the emissions from Paris between 7:00 and 8:00. a) Response function for the emissions from Paris between 5:00 and 11:00 (i.e., sum of the response functions for the hourly emissions from Paris between 5:00 and 11:00). c) Response function for the NEE between 7:00 and 8:00. d) Response function for the NEE between 5:00 and 11:00 (i.e., sum of the response functions for the hourly NEE between 5:00 and 11:00). The longitudes and latitudes of the domain are indicated in degrees East and North.