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Satellite observations of large power plants and megacities from GOSAT

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Fossil fuel CO_2 emissions are a major source of CO_2 to the global carbon cycle over decadal time scales and international efforts to curb those missions are required for mitigating climate change. Although emissions from nations are estimated and reported to help monitor their compliance of emission reductions, we still lack an objective method to monitor emissions directly. Future carbon-observing space missions are thus expected to provide an independent tool for directly measuring emissions. We proposed and have implemented satellite observations specifically over intense large point sources (LPS), including large fossil-fueled power plants and megacities, worldwide (N > 300) using the Japanese Greenhouse Gases Observing SATelllite (GOSAT). Our target LPS sites have been occasionally included in the observation schedule of GOSAT and the measurements are made using the target observation mode. This proposal was officially accepted by the GOSAT project office and we have attempted to use these data to detect signatures of man-made greenhouse gas emissions. We have submitted our locations of interest on a monthly basis two month prior to observation. We calculated the X_{CO2} concentration enhancement due to the LPS emissions. We analyzed GOSAT X_{CO2} retrievals from four research groups (five products total): the National Institute for Environmental Studies (NIES) (both the NIES standard Level 2 and NIES-PPDF products), the NASA Atmospheric CO_2 from Space (ACOS) team (ACOS Level 2 product), the Netherlands Institute for Space Research (SRON)/Karlsruhe Institute of Technology, Germany (RemoTeC), and the University of Leicester, UK (Full-Physics CO_2 retrieval dataset). Although we obtained fewer retrieved soundings relative to what we requested (probably due to geophysical difficulties in the retrievals), we did obtain statistically significant enhancements at some LPS sites where weather condition were ideal for viewing. We also implemented simulations of enhanced X_{CO2} using a global Eulerian-Lagrangian coupled atmospheric transport model (GELCA) and a high-resolution fossil fuel emissions dataset (Odiac). Odiac includes emissions information on the power plants requested in our target observations. Our model simulations tend to underestimate the enhancements, but showed good correlation with observed enhancements.