

## Summary

The Japan Aerospace Exploration Agency (JAXA) will present the latest Earth observation activities related to the monitoring of Greenhouse Gas (GHG) emission in global, regional, and local scale. For a local scale, JAXA has newly developed the method to estimate the emissions, based on the difference of CO<sub>2</sub> partial column density between the upper and lower troposphere. JAXA will present the recent efforts on estimating anthropogenic emissions from megacities related to COVID-19 pandemic.

### How satellite can monitor emissions?

GOSAT has the only asset of coincident solar and thermal measurements, which provide partial column information upper troposphere (4-12km) and lower troposphere (0-4 km). We then assumed that the upper partial column results represent background CO<sub>2</sub> concentrations, which are less affected by the city, while the lower partial column results track the CO<sub>2</sub> concentration changes within the city. If so, subtracting monthly averages the upper partial column values over the city from the lower partial column estimates should largely remove the seasonally-varying background values and yield and estimate of the CO<sub>2</sub> enhancements near the surface over the city.

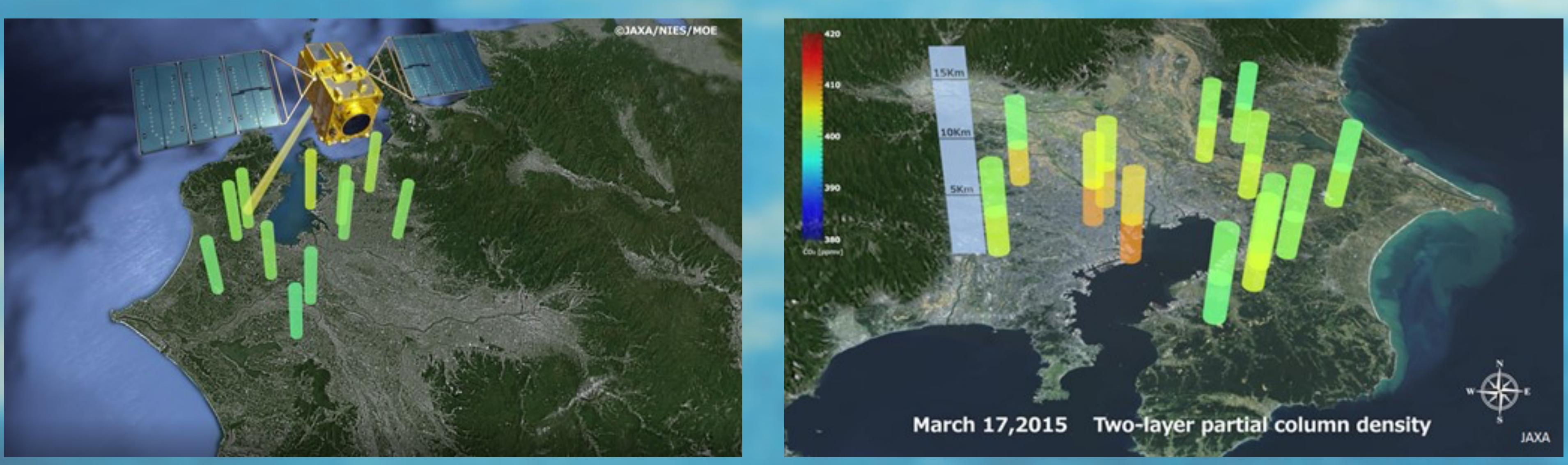
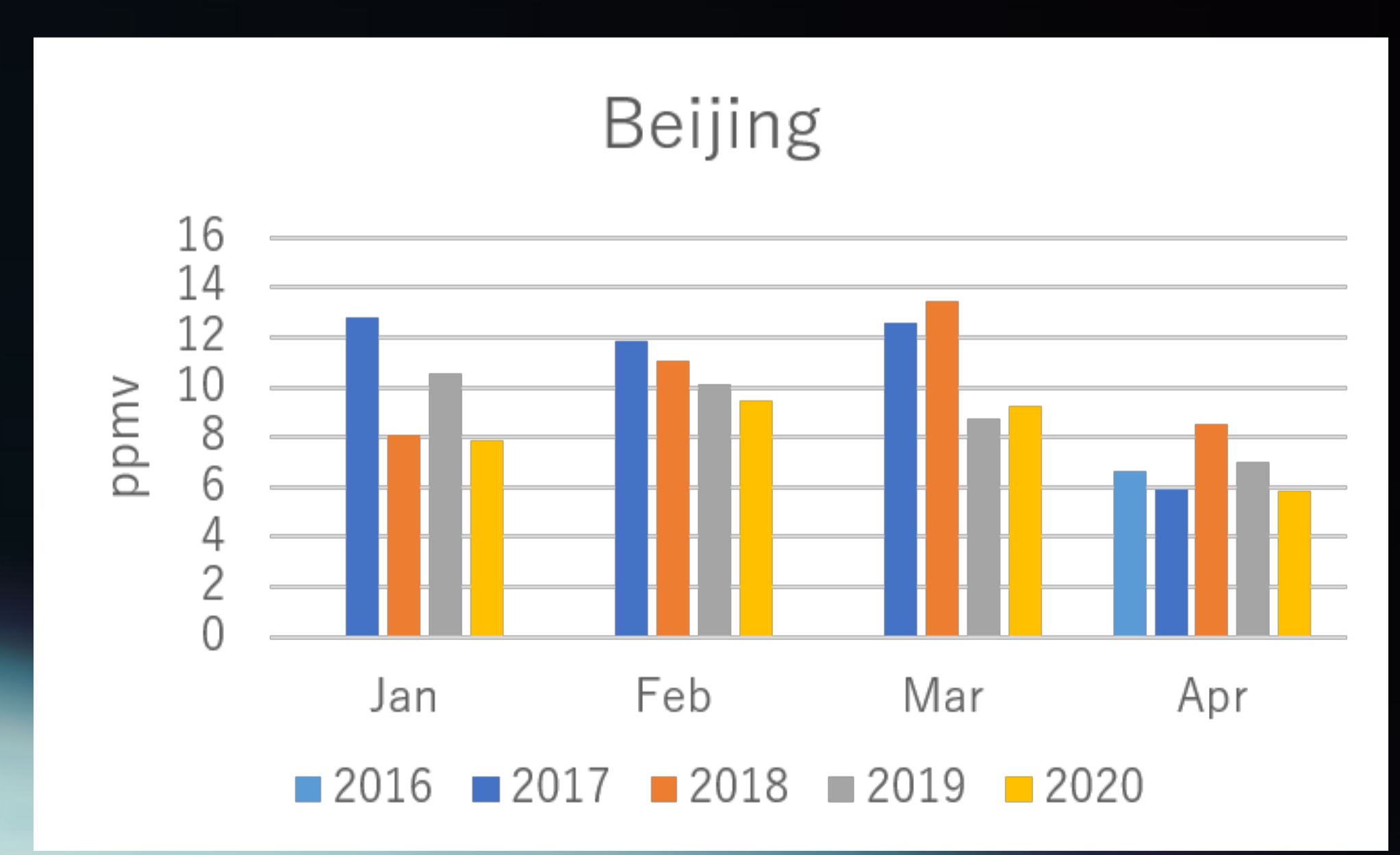
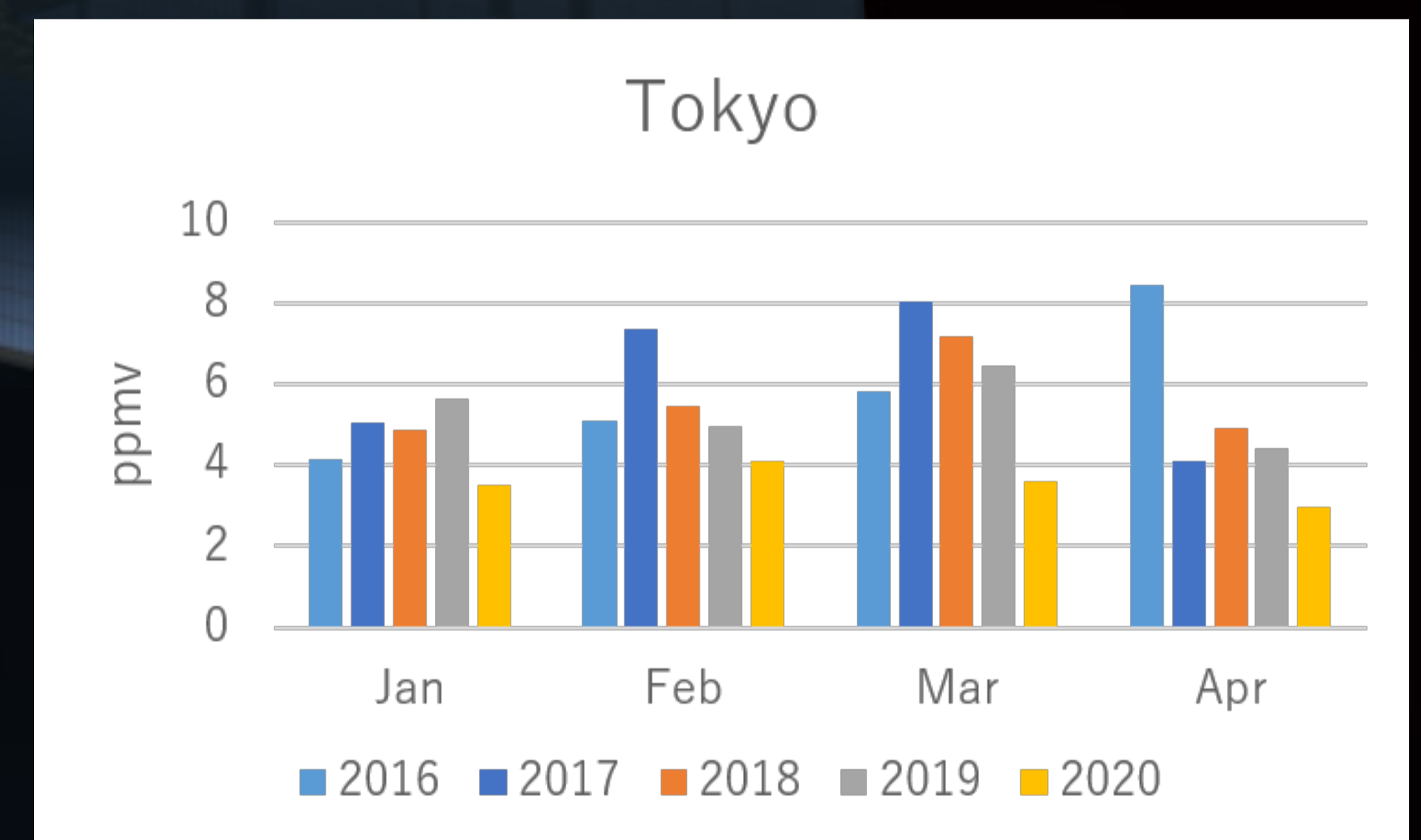
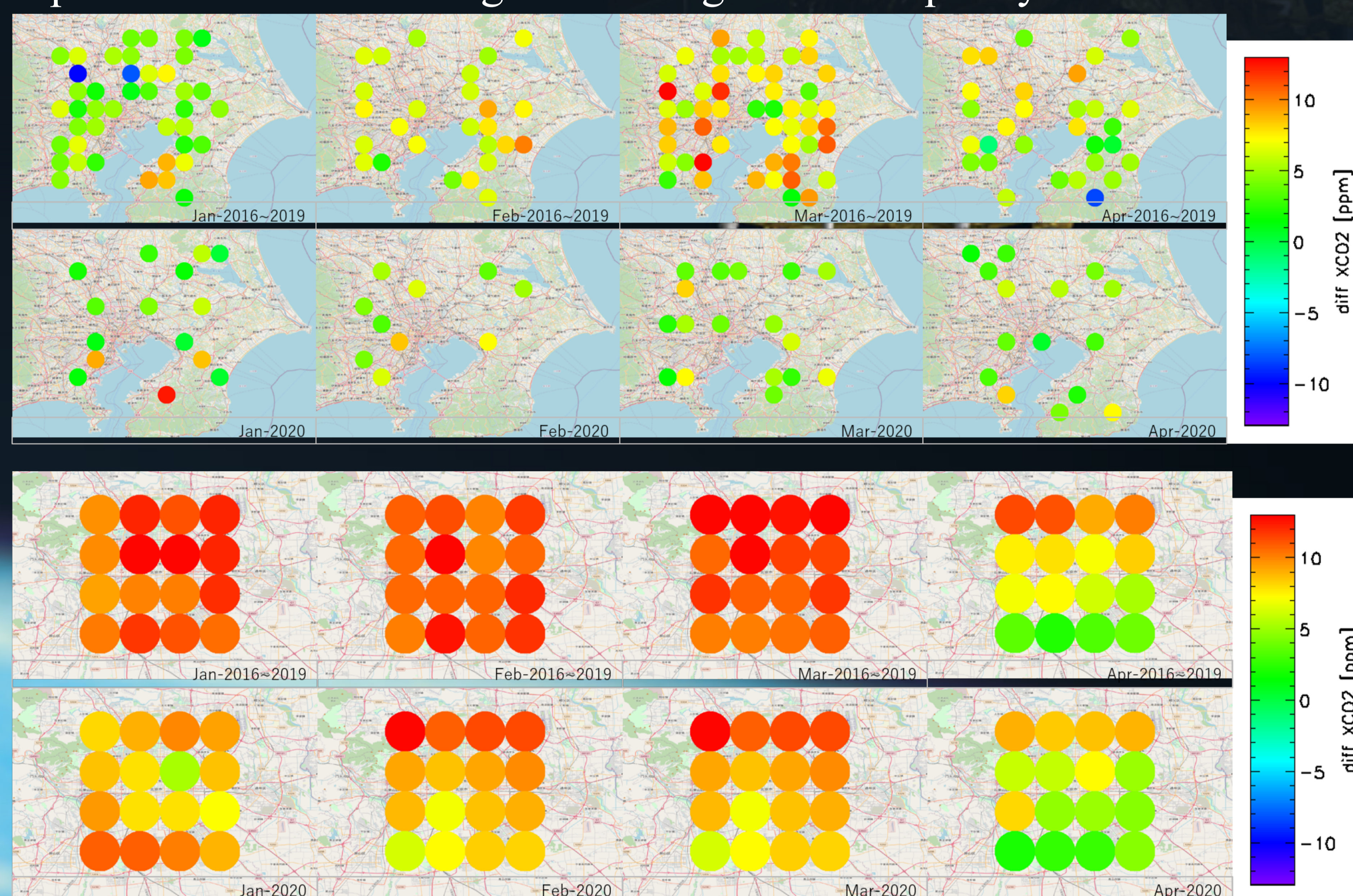
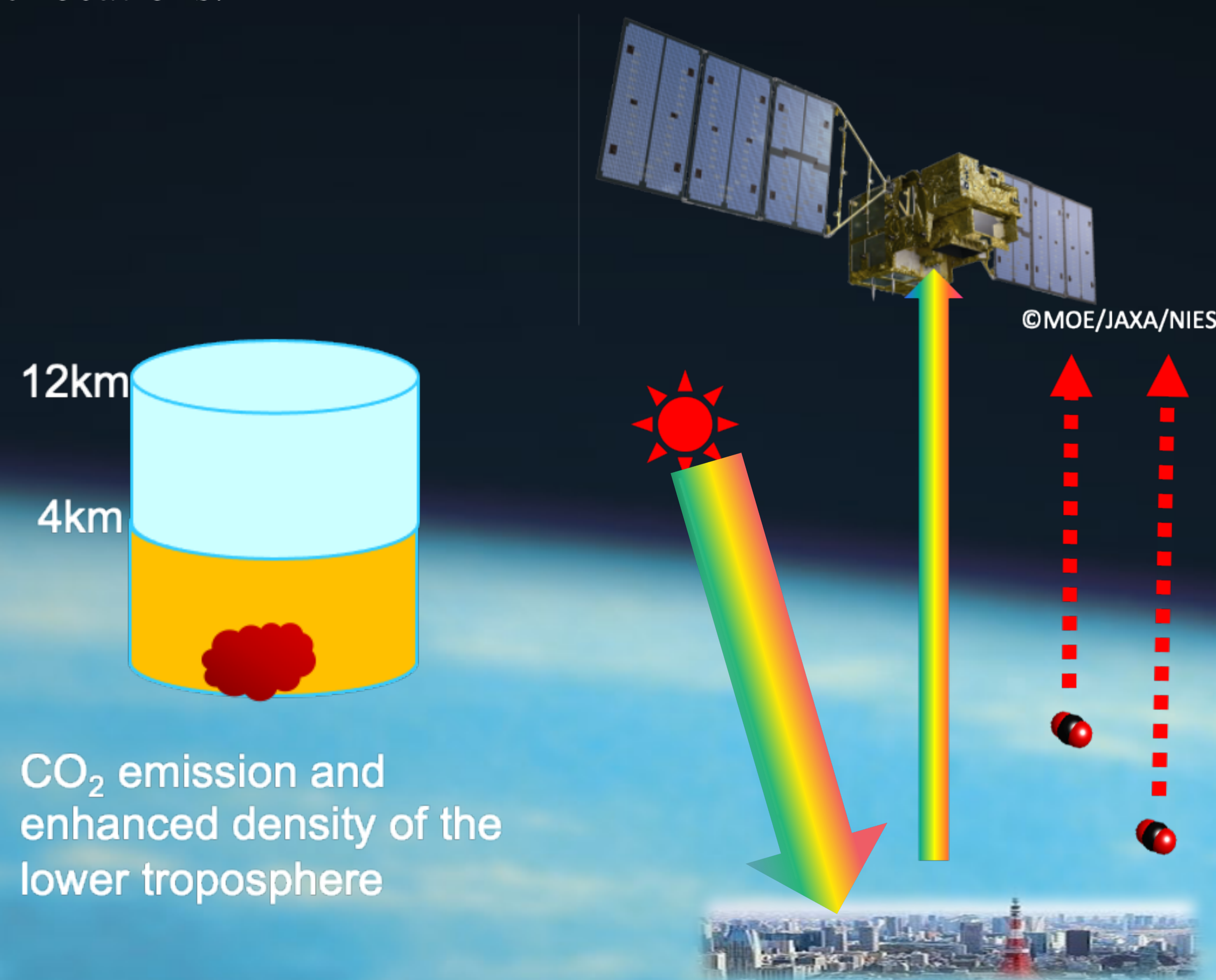
The GOSAT partial column products are provided in long term over 11 years with frequent target observations at large cities over 50 locations.

### CO<sub>2</sub> density changes over Large Urban areas

The largest changes in economic activity associated with the COVID-19 pandemic have been reported in the large urban areas where most people live and work. We derived monthly averages of CO<sub>2</sub> enhancements related to CO<sub>2</sub> flux index over Beijing, Shanghai, Tokyo, New York, Mumbai, Delhi, and Dhaka for January through April of each year from 2016 through 2020 by using GOSAT CO<sub>2</sub> tropospheric partial column density products. The monthly average CO<sub>2</sub> enhancements over Tokyo and Beijing are shown in the bar graphs and the target maps from GOSAT observations. While the CO<sub>2</sub> enhancements vary from month to month, they are generally smaller in 2020 than in earlier years.

The results for each month in 2016-2019 were averaged together to produce a background climatology of CO<sub>2</sub> enhancements over the city. Results for January through April of 2020 are compared to corresponding results from the 2016-2019 climatology for each city. Here, all months in 2020 show reduced CO<sub>2</sub> enhancements relative to prior years. While this behavior is consistent with the reported COVID-19-related reductions fossil fuel emissions, it is important to remember that these atmospheric results include contributions from photosynthesis and respiration from the land biosphere within and near the city as well as fossil fuel emissions.

JAXA GOSAT and GOSAT-2 will be collaborated with NASA OCO-2 and ESA TROPOMI to challenge to track the COVID-19 pandemic influence on greenhouse gas and air quality.



Left panels: Monthly lower tropospheric CO<sub>2</sub> enhancements map over Tokyo and Beijing for January through April 2020 compared with the 2016-2019 monthly climatology (GOSAT target observations are shown in color-coded circles of 10 km diameter field of view.)  
 Right panels: Monthly lower tropospheric CO<sub>2</sub> enhancements chart over Tokyo and Beijing for January through April