A high-resolution fossil fuel CO2 emission gridded dataset for tracer transport simulations and flux inversions: An overview, evaluations, applications and future perspectives

*Tomohiro Oda[1,2], Shamil Maksyutov [3], Miguel O. Roman [2,4], Zhousen Wang [4], Thomas Lauvaux[6,5], Sha Feng [5], Rostyslav Bun [7,8], James Wang [2,1], Randy Kawa [1], Lesley Ott[1], Steven Pawson[1]

1. NASA Goddard Space Flight Center, Greenbelt, MD, USA , 2. Universities Space Research Association, Columbia, MD, USA , 3. Center for Global Environmental Research, National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan , 4. Terrestrial Information Systems Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD, USA , 5. Department of Meteorology and Atmospheric Science, Penn. State University, State College, PA, USA , 6. Laboratoire des sciences du climat et de l'environnement, Gif sur Yvette, France, 7. Lviv Polytechnic National University, Lviv, Ukraine , 8. University of Dąbrowa Górnicza, Górnicza, Poland

Carbon dioxide (CO_2) emissions from fossil fuel combustion (Fossil fuel CO_2, FFCO2) is the largest input to the global carbon cycle over the decadal time scales. FFCO2 needs to be accurately quantified and monitored in order to deduce the carbon uptakes by natural sinks from atmospheric measurements as well as support the emission reduction and management. The Open-source Data Inventory for Anthropogenic CO_2 (ODIAC) is a global, high-spatial resolution (1x1km) gridded FFCO2 emission data product. We first pioneered the combined use of the point source information and satellite-observed nighttime lights data for emission downscaling in order to achieve global 1×1 km spatial resolution emission fields. The use of nightlight data allows us to observe dynamic changes in emissions spatial distributions in a timely manner and incorporate these into the emission field. Since its establishment in 2009, ODIAC has been extensively used in global and regional flux inversions especially with CO_2 data collected by carbon observing satellites, such as the Japanese Greenhouse gas Observing SATellite (GOSAT) and NASA’s Orbiting Carbon Observatory 2 (OCO-2). ODIAC has been also successfully applied to studies for localized emissions point sources such as power plants and cities. In order to further improve the accuracy of the emission downscaling, we have examined NASA’s new Visible Infrared Imaging Spectrometer Suite (VIIRS) Nighttime Environmental Product. An accurate global emission disaggregation is one of the key elements of future Monitoring and Verification Support (MVS) scientific systems that consist of the carbon modeling and data assimilation. Our advanced satellite-based emission downscaling model holds the promise of playing a critical role in such future systems.

Keywords: CO2, fossil fuel CO2 emissions, Carbon cycle, Remote sensing, GOSAT, OCO-2

