Geophysical Research Abstracts
Vol. 20, EGU2018-5552, 2018
EGU General Assembly 2018

The ODIAC – Space-based Mapping of Fossil Fuel Carbon Dioxide Emissions in Support of Carbon Cycle Sciences and Climate Mitigation

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The Open-source Data Inventory for Anthropogenic CO_2 (ODIAC) is a global high-spatial resolution gridded emission data product for carbon dioxide (CO_2) emissions from fossil fuel combustion. We first introduced the combined use of the point source information and satellite-observations of nighttime lights for emission downscaling in order to achieve global 1×1 km spatial resolution emission fields. The ODIAC was primarily designed to prescribe high-resolution CO_2 transport model simulations for inverse flux calculation especially using data collected by carbon observing satellites such as the Japanese Greenhouse gas Observation SATellite (GOSAT) and NASA's Orbiting Carbon Observatory 2 (OCO-2). Leveraging the legacies of emissions products from the Carbon Dioxide Information Analysis Center (CDIAC), the ODIAC provides an annually-updated, complete global picture of fossil fuel emissions that allows the data users to prescribe their simulations in a comprehensive manner. We also project the CDIAC emissions over the recent years using global fuel statistics in order to support scientific investigations that utilize CO_2 data collected near-real time.

Since its establishment in 2009, the ODIAC emission data product has been extensively used in global and regional flux inversions and also successfully applied to studies for localized emissions sources such power plants and cities. The good model reproducibility of the atmospheric CO_2 observations in transport model simulations supports the fair validity of the ODIAC space-based emission downscaling even at a high spatial resolution. To further improve the accuracy of the emission disaggregation, we have explored the use of other remote sensing data such as new NASA's Visible Infrared Imaging Spectrometer Suite (VIIRS) Nighttime Environmental Product (nightlight) and LandSat data. We confirmed that the excellent performance of the VIIRS nightlight data in spatial emission allocations at regional scales as well as spatial pattern depictions of emissions at urban scales from an extensive comparison to a fine-grained country emission inventory as well as high-resolution WRF transport model simulations.

The ability to create global high-resolution subnational spatial emissions patterns from emissions reported on country basis is one of the key elements of future Monitoring and Verification Support (MVS) scientific systems. Our future advanced satellite-based emission downscaling model holds the promise of playing a critical role, especially in implementing such systems operationally. In the presentation, we also discuss current technical limitations, challenges, difficulties and future perspectives of our contributions to carbon cycle sciences and climate mitigation.