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Near-real-time global gridded daily CO₂ emissions

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Timely, fine-grained gridded carbon emission datasets are particularly important for global climate change research. Often, fine-grained datasets are challenging to visualize over the globe, and clear visualization tools are also needed. Therefore, we present a near-real-time global gridded daily CO₂ emissions dataset (GRACED). GRACED provides gridded CO₂ emissions at a 0.1° × 0.1° spatial resolution and 1-day temporal resolution from cement production and fossil fuel combustion over seven sectors, including power, industry, residential consumption, ground transportation, domestic aviation, international aviation, and international shipping. GRACED is prepared from the near-real-time daily national CO₂ emissions estimates (Carbon Monitor), multi-source spatial activity data and satellite NO₂ data for time variations of those spatial activity data. Here, we examined the spatial patterns of sectoral CO₂ emission changes from January 1, 2019, to December 31, 2021. In 2021, most regions showed rapid rebounds in carbon emissions compared with 2020, reflecting the continuing challenges to accelerate climate mitigation in the post-COVID era. GRACED provides the most timely and more refined overview than any other previously published datasets, which enables more accurate and timely identification of when and where fossil CO₂ emissions have rebounded and decreased as the world recovers from COVID-19 and witnesses contrasted efforts to decarbonize energy systems. Uncertainty analysis of GRACED gives a grid-level two-sigma uncertainty of value of ±19.9%, indicating the reliability of GRACED was not sacrificed for the sake of higher spatiotemporal resolution that GRACED provides. In addition, we also examined the distribution of emission in a grid-wise perspective for major emission datasets, and compared it with GRACED. The similarity in emission distribution was observed in GRACED and other datasets. One of the advantages of our dataset is that it provides worldwide near-real-time monitoring of CO₂ emissions with different fine spatial scales at the sub-national level, such as cities, thus enhancing our comprehension of spatial and temporal changes in CO₂ emissions and anthropogenic activities. With the continued extension of GRACED time series, we present crucial daily-level input to analyze CO₂ emission changes in the post-COVID era, which will

ultimately facilitate and aid in designing more localized and adaptive management policies for the purpose of climate change mitigation in the post-COVID era.