Impact of 2019 mid-west flood on CO_2 and CH_4 using yearly WRF-GHG simulations over the contiguous United States

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Abstract

Sources and sinks of the two most important greenhouse gases CO_2 and CH_4 at regional to continental scales remain poorly understood. In our previous work, the WRF-VPRM, a weather-biosphere-online-coupled model in which the biogenic CO_2 fluxes are handled by the Vegetation Photosynthesis and Respiration Model (VPRM), was further developed by coupling with the CarbonTracker global CO_2 simulation and incorporating optimized terrestrial CO_2 flux parameterization (Hu et al., 2021; Hu et al., 2020). In this work, an enhanced version of WRF-VPRM by including CH_4 (referred to as WRF-GHG hereafter) is further developed by coupling with the Copernicus Atmosphere Monitoring Service (CAMS) CH_4 global simulation for the initial and boundary conditions and the WetCHARTs wetland CH_4 emissions and NEI2017 anthropogenic CH_4 emissions, which dominate emissions over the contiguous United States (CONUS). Yearly WRF-GHG simulations are conducted for year 2018 and 2019 over CONUS at a horizontal grid spacing of 12 km to examine the impact of 2019 abnormal mid-west precipitation on CO_2 and CH_4 fluxes and atmospheric concentrations, with the simulation for 2018 serving as a baseline for comparison, similarly to Yin et al (2020). Simulated CO_2 and CH_4 are evaluated using remotely sensed data from Total Carbon Column Observing Network (TCCON), OCO-2, TROPOMI, and in-situ measurements from the GLOBALVIEW obspack data. WRF-GHG has been shown to capture the monthly variation of column-averaged CO_2 concentrations (XCO_2) and episodic variations associated with frontal passages. In this work, we will show that TCCON XCH_4 shows mild seasonal variation and more prominent episodic variations, which are captured by WRF-GHG. As a case study, the 2019 May flood delayed growing season in mid-west and the typical spring and summer drawdown of atmospheric CO_2 by 1-3 weeks. Obspack and TROPOMI data indicate higher CH_4 in the mid-west in July and August, in 2019 relative to 2018, which we hypothesize is related to the abnormal precipitation in 2019 in the region that induces more wetland CH_4 emissions. The WRF-GHG model significantly underestimates CH_4 concentration in mid-west in summer 2019 when the WetCHARTs wetland CH_4 emissions are driven by ERA-Interim reanalysis precipitation, which is known to be underestimated. An updated WetCHARTs wetland CH_4 emissions driven by the PRISM precipitation data are currently being produced at JPL, which are expected to reduce the WRF-GHG CH_4 bias, as wetland fluxes are highly sensitive to inundation from precipitation.

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