Detectiibility of ocean flux variations from OCO-2 observatiosn

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Ocean pCO2 observations suggest dynamic ocean carbon cycling, driven both by climate trends and internal variability. Here, we assess whether the imprint of seasonal and interannually varying ocean fluxes are detectible in state-of-the-art OCO-2 space based observatiions. With a near-global coverage, this dataset provides a first opportunity to directly observe seasonality and IAV in atmospheric CO2 over remote ocean regions. We assess the impact of ocean fluxes on the OCO-2 record using atmospheric transport simulations with underlying gridded air-sea CO2 fluxes from observation-based products. We use three observation-based products to bracket the likely range of ocean air-sea flux contributions to XCO2 variability (over both land and ocean) within the GEOS-Chem atmospheric transport model. We find that seasonal cycles due to ocean fluxes are masked by terrestrial fluxes, and the magnitude of seasonal cycles in XCO2 due to ocean fluxes alone is well within the random noise of OCO-2 observations inferred from a geostatistical variance budget. In terms of interannual variations, we find that the magnitude of XCO2 IAV generated by the whole ocean is masked by random noise. Furthermore, depending on location and flux product, between 20-80% of the IAV in the simulations is caused by IAV in air-sea CO2 fluxes, with the remainder due to IAV in atmospheric winds, which modulate the atmospheric gradients that arise from climatological ocean fluxes. The simulation results based on all three flux products show that even within the Northern Hemisphere atmosphere, Southern Hemisphere ocean fluxes are the dominant source of variability in XCO2. Our results show that the small magnitude of the air-sea flux impacts on XCO2 presents a substantial challenge for detection of ocean- driven IAV from OCO-2, with implications for future CO2-observing missions.

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