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# Variation of surface $CO_2$ fluxes inferred from surface and space-based $CO_2$ observations: the role of fires and the biosphere

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A major advantage of space-based observations over in situ measurements is their global coverage, in particular over the tropics where $CO_2$ fluxes have strong inter-annual variations. However, satellite measurements are generally less accurate than the in situ data, and have variations in spatial coverage due to, for example, cloud coverage. We use an ensemble kalman filter to infer surface $CO_2$ fluxes from 2009 to 2015 inclusive using $XCO_2$ retrievals from the Greenhouse gases Observing SATellite (GOSAT) from the University of Leicester (UoL V7) and in situ $CO_2$ data. Resulting a posteriori atmospheric $CO_2$ mole fractions agree better with independent surface and aircraft observations than a posteriori values inferred from individual data sets. These a posteriori $CO_2$ fluxes show significant inter-annual variations at global and regional spatial scales. For example, the inversion shows elevated net emission (over 1 GtC/yr) over tropical regions during the strong 2015 El Nino event. Midlatitude terrestrial a posteriori fluxes also show large interannual variations, particularly over Eurasia temperate. We use data and biosphere models to understand the roles of fire and the biosphere in determining these observed variations.