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Interpreting the variability of satellite observations of CO_2 column using a chemistry transport model: application to SCIAMACHY data over North America

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We use the GEOS-Chem chemistry transport model to interpret observed variability of CO_2 columns (Ω), and associated column volume mixing ratios (CVMR), from the SCIAMACHY satellite instrument during the 2003 growing season over North America. Model "tagged" tracers of CO_2 represent individual geographical source and sinks, which are subsequently mapped to column space using the instrument averaging kernel. The model bias is greatest at latitudes between 50 and 70 degrees north during midsummer at the peak of biospheric uptake. During that time model column CVMRs and surface concentrations converge, reflecting the strong influence of the biosphere on lower tropospheric CO_2 columns. Background Ω values show only large-scale variability reflecting vertically integrated atmospheric transport patterns. We show using the model tagged tracers that the North American land biosphere dominates the variability of CO_2 columns during summertime, with smaller contributions from North American biomass burning and fuel combustion sources. We also show that the land biosphere from boreal Asia and eastern Asia contribute significantly to variability of column CO_2 over North America with implications for flux inversions. The monthly mean Jacobian matrix for North America shows that specific source and sink signatures have an atmospheric e-folding lifetime of 3-4 months, beyond which time they are too well-mixed in the atmosphere to interpret.