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Global estimates of CO sources with high resolution by adjoint inversion of multiple satellite datasets (MOPITT, AIRS, SCIAMACHY, TES)

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We combine CO column measurements from the MOPITT, AIRS, SCIAMACHY, and TES satellite instruments in a full-year (May 2004 - April 2005) global inversion of CO sources at 4°x5° spatial resolution and monthly temporal resolution. The inversion uses the GEOS-Chem chemical transport model (CTM) and its adjoint applied to MOPITT, AIRS, and SCIAMACHY. Observations from TES, surface sites (NOAA/GMD), and aircraft (MOZAIC) are used for evaluation of the a posteriori solution. Using GEOS-Chem as a common intercomparison platform shows global consistency between the different satellite datasets and with the in situ data. Differences can be largely explained by different averaging kernels and a priori information. The global CO emission from combustion as constrained in the inversion is 1350 Tg/yr. This is much higher than current bottom-up emission inventories. A large fraction of the correction results from a seasonal underestimate of CO sources at northern mid-latitudes in winter and suggests a larger-than-expected CO source from vehicle cold starts and residential heating. Implementing this seasonal variation of emissions solves the long-standing problem of models underestimating CO in the northern extratropics in winter-spring. A posteriori emissions also indicate a general underestimation of biomass burning in the GFED2 inventory. However, the tropical biomass burning constraints are not quantitatively consistent across the different datasets.