Top-down Estimates of Black Carbon Emissions in the Western United States Using the Adjoin of GEOS-Chem

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We estimate black carbon (BC) emissions in the western United States (WUS) for July-September 2006 by inverting surface BC concentrations from the Interagency Monitoring of PROtected Visual Environment (IMPROVE) network using the GEOS-Chem chemical transport model and its adjoint at both 2° × 2.5° and 0.5° × 0.667° (nested over North America) horizontal resolutions. Simulated surface BC concentrations with the a posteriori emissions capture the observed major fire episodes at many sites and substantial enhancements at the 1-2 and 2-3 km altitude ranges The a posteriori emissions lead to substantial bias reductions in the simulated surface BC concentrations (~ 50% on average) at both resolutions. Anthropogenic emissions in the WUS increase by about a factor of 2 from adjoint inversions while reduce by ~50% from analytical inversions; biomass burning emissions increase by about factors of 2 and 3 from adjoint and analytical inversions. We believe that the differences between the analytical and adjoint inversion results are partially because that the inversion system has trouble to effectively distinguish different BC emission sectors at grid-based resolution when anthropogenic and biomass burning emissions are collocated. The differences are also due to the large uncertainties in the bottom-up biomass burning emissions, which may force adjoint system to falsely increase anthropogenic emissions when biomass burning emissions are not strong enough.