Estimated Interannual Variability of CO_2 Fluxes During the 1990s

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A mass balance inversion and a modified Kalman filter were used in conjunction with an atmospheric transport model and the GLOBALVIEW data set to estimate the fluxes of CO_2 from land and ocean regions during the 1990s. Both techniques are time dependent and recursive in the sense that fluxes derived at a particular time are used to obtain the fluxes at subsequent times. The mass balance inversion represents an improvement over previous implementations of this technique since the response functions are calculated for an arbitrary length of time allowing fluxes to be influenced by more distant source regions. Likewise, the modified Kalman filter employed here is a much less numerically intensive calculation enabling estimates to be made relatively inexpensively for a number of years. Both approaches differ from Bayesian techniques commonly employed to deduce carbon fluxes in that very little use is made of prior flux estimates and associated prior flux error covariance estimates. Thus both inversions are essentially unconstrained. This allows meaningful comparisons with both satellite-derived Net Ecosystem Production (NEP) and ocean flux estimates.

Both inversion techniques result in flux estimates that are roughly consistent with satellite-derived estimates of NEP. Both the amplitude and the phase of the annual cycle of CO_2 fluxes from the terrestrial biosphere are well captured, although the inverse calculations tend to suggest more uptake during the northern hemisphere growing season and more respiration, particularly during the northern hemisphere autumn. Agreement with the observationally deduced global total ocean fluxes is very good for some years and within 2.0 or 3.0 GtC yr^{-1} for other years. Both land and ocean fluxes exhibit considerable interannual variability with anomalies that may be associated with ENSO and Mt. Pinatubo. Unlike previous studies, which found uptake by the terrestrial biosphere to be larger in North America or evenly distributed between Eurasia and North America, this study finds uptake by the terrestrial biosphere is largest in Eurasia.