**BAYSIAN INVERSION OF A TERRESTRIAL ECOSYSTEM MODEL AND UNCERTAINTY ANALYSIS**

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We applied the Bayesian probability inversion and a Markov Chain Monte Carlo (MCMC) technique to a terrestrial ecosystem model and analyzed uncertainties of estimated carbon transfer coefficients and simulated carbon pool sizes. The study used six data sets of soil respiration, woody biomass, foliage biomass, litterfall, carbon content in the litter layers, carbon content in mineral soil measured under both ambient $CO_2$ (350 ppm) and elevated $CO_2$ (550 ppm) plots from 1996 to 2000 at the Duke Forest Free-Air $CO_2$ Experiment (FACE) site.

A Metropolis-Hastings algorithm was employed to construct a posterior probability density function (PPDF) of carbon transfer coefficients based on prior information of model parameters, model structure and the six data sets (Fig 1, 2). The constructed PPDFs indicate that the transfer coefficients from pools of non-woody biomass (parameters $c_1$), woody biomass ($c_2$), and structural litter ($c_4$) are well-constrained by the six data sets under both ambient and elevated $CO_2$. The data sets also give moderate information to the transfer coefficient from slow soil carbon pool ($c_6$). However, the transfer coefficients from pools of metabolic litter ($c_3$), microbe ($c_5$), and passive soil carbon ($c_7$) are poorly constrained (Fig 1, 2). Parameter estimation based on the samples is summarized in Table 1.

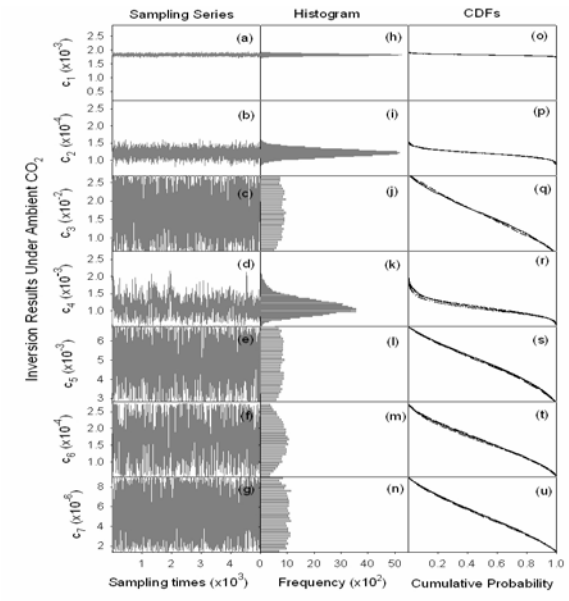


Fig. 1

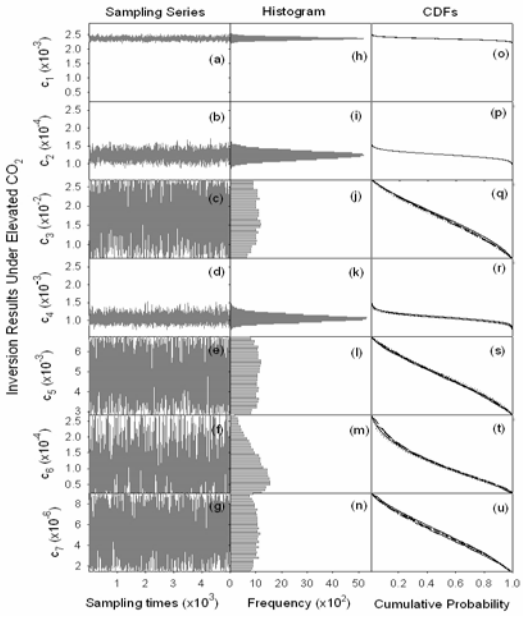


Fig. 2

Under both ambient and elevated $CO_2$, the cross-correlation analysis shows that the seven parameters are not inter-correlated except for the pair $c_3$ and $c_4$. The simulated and observed data sets using mean value estimates of the parameters fit closely. Under elevated $CO_2$ the pool size prediction distributions are shifted to the right along the x-axes (Fig. 3), suggesting that elevated $CO_2$ increased carbon sequestration in the forest ecosystem. The 95% confidence intervals of simulated carbon pool sizes are significantly shifted to the right for woody biomass, structure litter and slow SOM. However, the distributions of simulated carbon pool sizes in the other compartments are statistically overlapped.

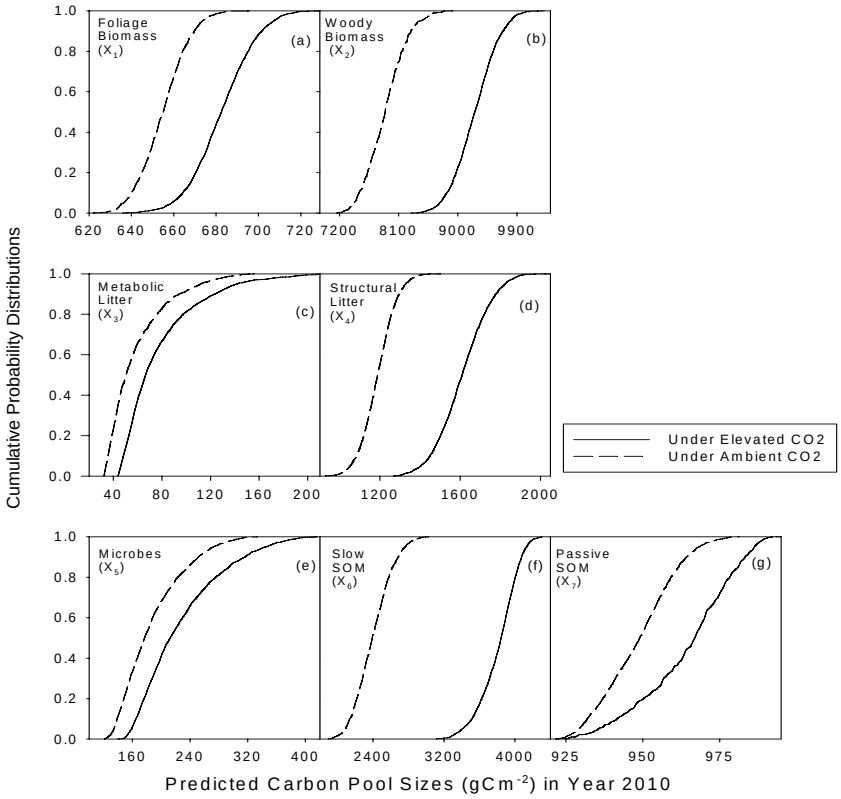


Fig. 3

**Table 1.** Estimation of parameters and estimation uncertainties.

| Parameters | ($gCg^{-1}\ d^{-1}$) | MLEs | Means | 95% high probability intervals |
|---|---|---|---|---|
| Ambient | $c_1$ ($\times 10^{-3}$) | 1.82 | 1.82 | (1.72, 1.89) |
| | $c_2$ ($\times 10^{-4}$) | 1.21 | 1.21 | (0.99, 1.43) |
| | $c_3$ ($\times 10^{-2}$) | - | 1.67 | (0.66, 2.70) |
| | $c_4$ ($\times 10^{-3}$) | 1.04 | 1.04 | (0.84, 1.24) |
| | $c_5$ ($\times 10^{-3}$) | - | 4.98 | (3.00, 6.84) |
| | $c_6$ ($\times 10^{-4}$) | 1.72 | 1.72 | (0.5, 2.75) |
| | $c_7$ ($\times 10^{-6}$) | - | 5.25 | (1.41, 8.99) |
| Elevated | $c_1$ ($\times 10^{-3}$) | 2.34 | 2.34 | (2.27, 2.47) |
| | $c_2$ ($\times 10^{-4}$) | 1.22 | 1.22 | (0.98, 1.44) |
| | $c_3$ ($\times 10^{-2}$) | - | 1.71 | (0.68, 2.72) |
| | $c_4$ ($\times 10^{-3}$) | 1.03 | 1.03 | (0.40, 1.51) |
| | $c_5$ ($\times 10^{-3}$) | - | 4.84 | (2.90, 6.84) |
| | $c_6$ ($\times 10^{-4}$) | 0.55 | 0.57 | (0.228, 2.2) |
| | $c_7$ ($\times 10^{-6}$) | - | 5.19 | (1.50, 9.10) |