Background

The IPCC recommends that nations attempt to reduce uncertainties when reporting forest greenhouse gas balances to the UNFCCC. When Tier 3 reporting is used, this can best be achieved by simulating carbon dynamics using spatially-explicit data that specify where forest disturbance events have occurred within the landscape being simulated. Such data are difficult to obtain, however, and often only “spatially-referenced” disturbance data are available – i.e., data that just specify how many hectares of forest within the landscape were affected by those disturbance events.

With spatially-explicit disturbance data the individual stands affected by each disturbance can be identified, and this allows their distinct characteristics – most importantly their species compositions and ages, which largely determine their carbon stocks – to be factored into calculations of landscape carbon fluxes each time a disturbance is simulated. Spatially-referenced disturbance data introduce uncertainty in the calculations, as the disturbances must be distributed among stands using rules and the among-stand variation in associated fluxes cannot be accounted for with precision.

We have investigated these uncertainties using the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3).

The Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

The CBM-CFS3 is an empirically-driven carbon dynamics model that simulates stand growth, litterfall, natural and anthropogenic disturbances, and dead organic matter decay, calculating and tracking the associated fluxes at annual time steps along the way. See Kurz et al. 2009, Ecological Modeling 220:480-504, for complete details.

The CBM-CFS3 can conduct both spatially-explicit and spatially-referenced simulations. When running in spatially-referenced mode it represents stands as records that it creates at the outset from a non-georeferenced forest inventory – i.e., data that just specify how many hectares of forest within the landscape were affected by those disturbance events.

The precision of the spatially-referenced runs increased – within-set variation in NBP decreased – as stands were targeted more precisely for disturbance by their characteristics. However, accuracy decreased rather than increased – within-set average NBP came to differ more from the spatially-explicit NBP estimate.

We investigated uncertainties introduced into Tier 3 carbon budget simulation by data that imprecisely identify which stands were affected by disturbances within the landscape being modeled. The results suggest that precise data on how disturbances were distributed among stands with respect to their characteristics can reduce uncertainties in calculations of landscape carbon balance. The carbon budget modeling community will benefit from using increasingly available high resolution maps of disturbances based on remotely-sensed data.

Summary

We investigated uncertainties introduced into Tier 3 carbon budget simulation by data that imprecisely identify which stands were affected by disturbances within the landscape being modeled. The results suggest that precise data on how disturbances were distributed among stands with respect to their characteristics can reduce uncertainties in calculations of landscape carbon balance. The carbon budget modeling community will benefit from using increasingly available high resolution maps of disturbances based on remotely-sensed data.

We thank the Commission for Environmental Cooperation of North America for financial and programmatic support.