Flux and Pool Equations

1.1. **Flux equations**

Six equations govern the movement of surface water and groundwater (and their associated carbon) into, within, and among watersheds. Each equation is of a form common to the Darcy equation for subsurface flow and the Manning equation for stream flow [*Dunne and Leopold*, 1978]. At a given time step, in each watershed, the equations for the amount of water flow for the fluxes GGO, GL, GT, LGO, LL, and TL are computed using equations of the following form:

$Flux_{ij,t} = max(0, k_f * (Head_{ij,t} / Distance_{ij})^{P1} * FlowWidth_{ij}^{P2})$

where

$Head_{ij,t}$ = the dynamic elevation difference (m) between pools i and j at the current time step t;

$Distance_{ij}$ = the fixed distance (m) between pools i and j;

$FlowWidth_{ij}$ = the fixed estimate of width of the flow (m) between the two pools;

(P1, P2) = {

(1,1) for the flows primarily below the surface (GGO, GL, GT, and LGO) and thus modeled with the Darcy equation;

(0.5, 0.667) for flows above the surface (LL and TL), and thus modeled using the Manning equation. }

k_f = the fixed flow rate coefficient for each flow (m^2/s), different for each of the five flows, but spatially unvarying across the study area. Values for these levels and flow coefficients were determined through model calibration as described in the main text. LGO flux occurred in a lake when the current lake volume was 0.85 * SV; and LLO flux occurred when the current lake volume was 1.2 * SV. Both factor values were estimated using model calibration.

Details of the parameters governing each flux are given in Table 2.

1.1.1. **Pool mass balance equations**

Water

The dynamic volume of each water pool in each watershed (m^3) are given by the following equations, computed for each watershed at each time step t:

$$V_L(t) = V_L(t-dt) + ((PL - EL) * LA + GL + TL + RU + LLI - LLO - LGO) * dt$$

$$V_G(t) = V_G(t-dt) + (D + GGI + LGI - GL - GT - GGO) * dt$$

$$V_T(t) = V_T(t-dt) + ((PT - EW) * TA + GT - TL) * dt$$

where

$V_L(t)$ = the volume of the lake at time t;

$V_G(t)$ = the volume of the groundwater in the watershed at time t; and

$V_T(t)$ = the volume of water in the wetlands of the watershed at time t.

<u>Carbon</u>

The dynamic size of the carbon pools in each watershed's lake (g) are given by the following equations, computed for each watershed at each time step t:

$$\mathrm{IC}(t) = \mathrm{IC}(t-dt) + (\mathrm{TLIC} + \mathrm{GLIC} + \mathrm{ATM} + \mathrm{PLIC} + \mathrm{RUIC} + \mathrm{LLIIC} - \mathrm{LLOIC} - \mathrm{LGOIC} + \mathrm{ILDELTIC}) * dt$$

$$\mathrm{OC}(t) = \mathrm{OC}(t-dt) + (\mathrm{TLOC} + \mathrm{GLOC} + \mathrm{RUOC} + \mathrm{AER} + \mathrm{LLIOC} + \mathrm{PLOC} - \mathrm{SED} - \mathrm{LLOOC} - \mathrm{LGOOC} + \mathrm{ILDELTOC}) * dt$$

where

IC(t) = the amount of Inorganic Carbon in the watershed's lake at time t;

OC(t) = the amount of Organic Carbon in the watershed's lake at time t; and

ILDELTIC, ILDELTOC are transformations among these carbon stocks within each lake.

References for Supplemental Material:

Dunne, T., and L. B. Leopold (1978), *Water in environmental planning*, 818 pp., W. H. Freeman, San Francisco.