Notes about tinker toy climate scenarios analysis

CTS SS SDS 24 Oct 2019

We created a wrapper script to let us play with some climate scenarios in the tinkerToy model.

Proportion of C input that is lost in hydrologic network, using base Savannah River network. Scenarios are:

* base condition (localCin=10, localPET=0.005) <note Hilary says 0.001 would be more accurate PET for Savannah River region>
* high C input (localCin=20, localPET=0.005)
* high precip (localCin=10, localPET=0.010)
* high C input AND high precip (localCin=20, localPET=0.010)

"0.127090087586772 0.127090087586772 0.0663060172769282 0.0663060172769282"

So just doubling the localCin doesn’t change proportion of C that is processed (though it does double the amount of C that is processed). Doubling the precipitation cuts the proportion of C that is processed almost in half. (Presumably the decreased residence time is offset, to some extent, by the increase in C that is loaded via discharge\*concentration effect).

Same thing, using an altered version of the Savannah River network where we insert 1000 lakes in place of 1000 1st order stream reaches. Total area of these lakes in the random realization that we are looking at is 168 km2.

"0.159260678404534 0.159260678404534 0.0881773502991847 0.0881773502991847"

Adding headwater lakes increases the proportion of the C that is processed in the network relative to the base case. Same effects as in previous network structure of increasing localCin and localPET.

And again, but this time using the version of the Savannah River network where we insert 1 large lake in place of a 7th order reach, this lake having same area as the summed area of the 1000 lakes in previous network structure.

"0.544235631924728 0.544235631924728 0.39683952286661 0.39683952286661"

Here is a better table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Hydrologic network structure** | **Base**  localCin=10, localPET=0.005 | **High C**  localCin=20, localPET=0.005 | **High P**  localCin=10, localPET=0.010 | **High C and High P**  localCin=20, localPET=0.010 |
| Real Savannah R. | 0.1271 | 0.1271 | 0.0663 | 0.0663 |
| Headwater lakes | 0.1593 | 0.1593 | 0.0882 | 0.0882 |
| Tailwater lake | 0.5442 | 0.5442 | 0.3968 | 0.3968 |

In summary

* Increasing CIn increases the amount of C that is processed but does not change the proportion of the C load that is processed.
* Increasing precipitation decreases the proportion of C that is processed, although this is a less than linear response because increasing the precip brings some C in at the same time.
* Adding lakes in the headwaters increases the proportion of C that is processed. Adding the same volume worth of lake as one big lake in the tailwaters has a very big effect in increasing the proportion of C that is processed, because most of the carbon in the network has to pass through there.

Given landscapes with same terrestrial cover (or actually the same delivery concentration of C to streams, represented as same localCin), but different aquatic network structure (streams only; many headwater lakes; one big tailwater reservoir), you expect C evasion to atmosphere to vary considerably.

Terrestrial-only C budget would assume that all of these landscapes had the same C balance, but actually some move a lot more C to the ocean and some move a lot more to the atmosphere.

This model can’t yet link terrestrial GPP and aquatic processing together for landscape-level picture quite as well as you might like – the only way to mimic change in terrestrial GPP is via localCin, which skips some steps (soil processes, mobilization of C from soil) where temperature and precipitation regime might have important effects on localCin.

Other things to think about

* What if C quality (i.e. k) also varies?
* Dynamic rather than steady state