LEO Science Meeting

1/26/2015

Marshall Building 531

Attending:

Luke Pangle

Till Volkmann

Matej Durcik

Peter Troch

Regis Ferriere

Marcel Schaap

Xubin Zeng

Russ Monson

Guo Yue Niu

Greg Barron-Gafford

Yuanhao

John Adams

Katerina Dontsova

Joost van Haren

Summary:

We discussed only the first agenda item – the upcoming rainfall applications on LEO-C and LEO-W. We agreed that 81 mm of irrigation will be applied to both of those landscapes later this week (currently scheduled for 1/30/2015). This application will exactly mimic the “test run” of the irrigation and sensor systems that was performed on LEO-E on January 25th, 2013.

We agreed that in late February of 2015 LEO-C and LEO-W will receive irrigation at a rate of 12 mm/h for 12 h (144 mm total). This is the same rate that was applied to LEO-E during the steady-state experiment of February 2013, and the 12 h duration will bring the landscapes to a very wet condition, but not so wet to induce saturation-excess overland flow. That expectation is based on the observed water table, soil moisture, and runoff dynamics during the experiment on LEO-E, which are now published in two articles.

In total, 264 mm of irrigation was applied to LEO-E between February 18th and 19th, 2013. For the remainder of the meeting we discussed how the remaining 120 mm of irrigation (after the 12 mm/h for 12 hour application) should be applied on LEO-C and LEO-W. The objectives are to apply the same amount of water as was applied to LEO-E, and to do so in a way that we believe brings these two landscapes to the state of greatest similarity to LEO-E. Four potential scenarios were discussed.

1. After the 144 mm application, allow for a short drying period (likely a few days), then apply the same rate (12 mm/h) for 10 h.
2. After the 144 mm application, immediately transition to a lower irrigation intensity, but maintain continuous irrigation until reaching a cumulative irrigation total of 264 mm.
3. After the 144 mm application, allow for a short drying period, and then apply irrigation at a lower rate (e.g. 6 mm/h) and longer duration (20 hours).
4. Repeat exactly the irrigation event applied to LEO-E in February 2013 – that is, 12 mm/h applied continuously for 22 h.

There was a consensus that it would be preferable not to have a drying period following the initial 144 mm. Guo-Yue’s sensitivity analysis suggested that the soil hydraulic properties near the downslope boundary of LEO-E are different than those for most of the upslope volume. The hypothesis is that displacement of fine particles toward the downslope boundary may have caused this apparent change in effective hydraulic properties. In soil-column experiments, Marcel has observed particle transport out of the columns during irrigation application equivalent to one pore volume (for LEO that is about 390 mm equivalent water depth). Since saturated flow is believed to be a requisite for that kind of particle transport, we reasoned that continuous irrigation would be more likely to cause similar particle displacement as is believed to have occurred on LEO-E than would a second irrigation pulse that follows a period of drying and water-table recession.

The rationale for scenario 4 was that the initial experiment on LEO-E led to a hydrological and geomorphological threshold event – the kind of event that is rarely monitored in nature, and almost never in a replicated manner. Despite the possibility of creating gullies on LEO-C and LEO-W that would have to be repaired, this could be an opportunity to study such an event in a replicated system, and with improved monitoring capabilities. For example, we have now replaced the vibrating wire piezometers with more reliable pressure transducers for monitoring water-table dynamics, and we could utilize the web cameras to better document the timing of gully formation.

After discussion there was general agreement that opportunities will exist for comparative analysis of hydrological and biogeochemical processes among the three slopes during this extreme event, without pushing the landscapes to the point of gully formation. The infiltration, water table, and seepage dynamics, and the carbon sequestration and export can be compared across slopes. The first 12 h of irrigation will provide insight into how hydrologically similar were the three landscapes even before the gully formation/repair on LEO-E. The calibrated hydrological model presented by Niu et al. can be used to simulate water flow through LEO-C and LEO-W, and serve as a tool to detect any differences in effective hydraulic properties (or their spatial distribution) among the three landscapes.

Next Steps:

Based on this discussion, Guo Yue and his students will now run a set of simulations using the hydrological model that was calibrated for LEO-E (calibrated based on the actual experimental data). Their simulations will focus on scenario 2, and will consider water table and runoff dynamics associated with different schemes for stepping down the rainfall intensity. The objective is to reach a pseudo-steady state condition, where a water table is maintained below the surface through the application of the remaining 120 mm.