ABSTRACT
Understanding the interaction of vegetation and hydrology and determining the changes in this relationship across spatial and temporal domains is critical for modeling landscape hydrology. Trees release water into the atmosphere via stomatal pores in exchange for carbon dioxide and play an important role in landscape hydrology. Our objective was to investigate the coupled spatial and temporal dynamics of vegetation and hydrological properties in a forested catchment covering 7900 m² area in central Pennsylvania at the Shale Hills Critical Zone Observatory. During 2010, we measured leaf area index (LAI) and canopy closure to characterize vegetation properties and measured soil water content, soil water tension and water table depth to characterize hydrological properties at a spatial grid of 70 sampling points across an entire watershed at 15-day intervals. We used geostatistical techniques to quantify spatial structure (semi-variograms) and visualize spatial patterns (Kriging) of vegetation and hydrological properties and their relationship to each other. Our results show an exponential increase (90-600 m) in spatial range from leaf onset (April) to leaf maturity (July) and subsequent decline (600-100 m) in spatial range from leaf maturity (July) to leaf senescence (October). Soil water content (at all measured depths) decreased from leaf onset to maturity and subsequently increased from leaf maturity to senescence. Results from this study suggest that the landscape canopy area and soil water become more homogenized and coupled from leaf onset to maturity (increasing spatial dependence and decreasing water content) and the landscape becomes more heterogeneous and uncoupled from leaf maturity to senescence (decreasing spatial dependence and increasing water content). Our results provide insight into tight coupling between vegetation and hydrology across space and time; incorporating these spatial and temporal feedbacks in hydrological models will improve current and future landscape modeling of temperate forests.

RESULTS

- Soil water content of all measured depths declined (F) from April (leaf onset) to July (leaf Maturity) which coincided with exponential increase in LAI (G).
- A subsequent increase in soil water content was observed from July (leaf maturity) to October (leaf senescence) (F) which coincided with exponential decline in LAI (G).
- LAI showed increasing spatial range from April (leaf onset) to July (leaf maturity) and decreasing spatial range from leaf maturity senescence (H).
- Landscape became more homogenized as spatial dependence increased from leaf onset to maturity (I).

CONCLUSIONS
- Results from this study suggest that the landscape canopy and soil water become more homogenized and coupled from leaf onset to maturity (increasing spatial dependence and decreasing water content) and the landscape becomes more heterogeneous and uncoupled from leaf maturity to senescence (decreasing spatial dependence and increasing water content).
- Our results provide insight into tight coupling between vegetation and hydrology across space and time; incorporating these spatial and temporal feedbacks in hydrological models will improve current and future landscape modeling of temperate forests.

FUTURE WORK
- Uncertainty in model parameters will be quantified from leaf onset till senescence.
- Spatial and temporal dynamics of other vegetation (e.g., canopy closure) and hydrological properties (e.g., water table depth, soil water tension) will be studied.

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