Landscape Patterns and Hydrologic Variability Affecting Soil Water Contents and Crop Yields and their Scaling Relationships

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Abstract. Landscape topography appears to control the spatial variability of soil moisture and plant growth through both short- and long-term processes. Long-term geomorphic and pedologic processes determine the spatially variable soil properties, while short-term hydrologic processes control the movement of water over and through the soils resulting in contemporary space-time patterns of soil-water content. Consequently, agricultural lands can be managed uniformly and receive relatively uniform rainfall amounts, yet measured crop yields exhibit large spatial variability. A brief literature review will be presented on the relationship of certain topographic attributes with the variability of soil properties (e.g., texture, depth, organic matter content), soil processes (soil water and related variables), and crop growth. The present field experiments are conducted on a farm in eastern Colorado with an undulating landscape of deep loess parent material, semi-arid climate and no irrigation. The experimental design and setup for high-resolution measurement of the surface elevation, soil water contents, soil hydraulic properties and crop yields will be discussed. Independent scaling of crop yield patterns using simple fractals will be presented. Then, the statistical relationships between crop yield, soil water content and a suite of topographic attributes will be summarized. This data set supports further nonparametric analyses of space-time patterns and numerical simulations to help identify which hydrologic processes of overland and subsurface flow are dominant over different space-time scales.