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Drainage system development of an Antarctic cold-based glacier: Wright Lower Glacier, McMurdo Dry Valleys.

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Catchment hydrology is a branch of the geosciences that is concerned with understanding how hydrological components interact and mitigate flow through and storage within a watershed. In recent times, catchment hydrologists have moved towards understanding catchments in an integrated manner, in an attempt to incorporate surface and subsurface hydrological processes alongside biogeochemical and ecological properties. Glacier hydrology is nestled within this paradigm, as a glacier can be viewed as its own watershed, as well as contributing to a wider catchment. Drainage systems on cold-based glaciers are often thought to be simple systems that can be approximated from the supraglacial components of temperate glaciers. Most studies concerning cold-based glacier drainage systems have only considered one facet of the system, with little regard for how the system components interact. Studying each component independently of the whole system constrains our ability to model drainage system function and development. This in turn restricts our potential to predict how drainage systems of cold glaciers may respond to environmental change. The overarching aim of this paper was to understand drainage system development of a cold-based glacier, and to assess whether our current understanding of supraglacial hydrological systems is consistent with the drainage systems that form on cold-based glaciers. This study evaluated the drainage system of the Wright Lower Glacier, McMurdo Dry Valleys, Antarctica, during the 2004/05, 2005/06 and 2006/07 ablation seasons. The study incorporated field, laboratory and numerical analyses, which resulted in a deeper understanding of the spatial and temporal variability of meltwater generation, drainage pathways, water stores and bulk discharge from the glacier. The findings showed that melt variability was driven by sediment and topographic variations, and that water storage in the form of cryoconite holes, intergranular flow, supraglacial ponds and refreezing dictated meltwater transmission to the glacier outlet. These results indicated that the structure, function and variability of the drainage system were inherently more complex than previous studies on supraglacial drainage systems had suggested. These new insights were combined together to construct a new conceptual model of the drainage system structure of a cold-based glacier. By taking a catchment hydrology approach, we show how a myriad of drainage pathways develop through a season, and how only by integrating all components together can we come close to understanding, and subsequently predicting, how water is generated, routed and discharged from polar glaciers.