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The McMurdo Dry Valleys, Antarctica: Terrestrial and aquatic ecosystems responding to climatic events that enhance hydrologic transport across the landscape (John Dalton Medal Lecture)

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While continuous monitoring of stream flow and stream temperature has been a widely used resource for some time, currently there is great potential to expand continuous monitoring to include important water quality parameters such as nutrients and dissolved organic material. In many systems distinguishing between watershed and stream ecosystem controls can be challenging, and the usefulness of such monitoring can be enhanced by application of quantitative models to interpret observed patterns. The glacial meltwater streams of the McMurdo Dry Valleys, Antarctica, are surrounded by large expanses of patterned ground devoid of plants. In contrast, many streams have thriving cyanobacterial mats that are freeze-dried through the winter and begin photosynthesis with the onset of flow. Thus, the daily signal in terms of biogeochemical processes controlling water quality is generated within the stream. As part of the McMurdo Dry Valleys Long Term Ecological Research project, we have conducted field experiments and developed coupled biogeochemical transport models for the role of hyporheic exchange in controlling weathering of major ions, microbial cycling of nitrogen species, and streams temperature regulation. We have also adapted modelling approaches from sediment transport to understand mobilization of stream biomass with increasing flows. These models are relevant to understanding the role of in-stream processes in diverse stream systems where watershed processes also contribute to observed patterns. In the future, monitored data may be directly incorporated into such process models to better understand rapid hydrologic change and their impact on water quality and aquatic ecosystems.