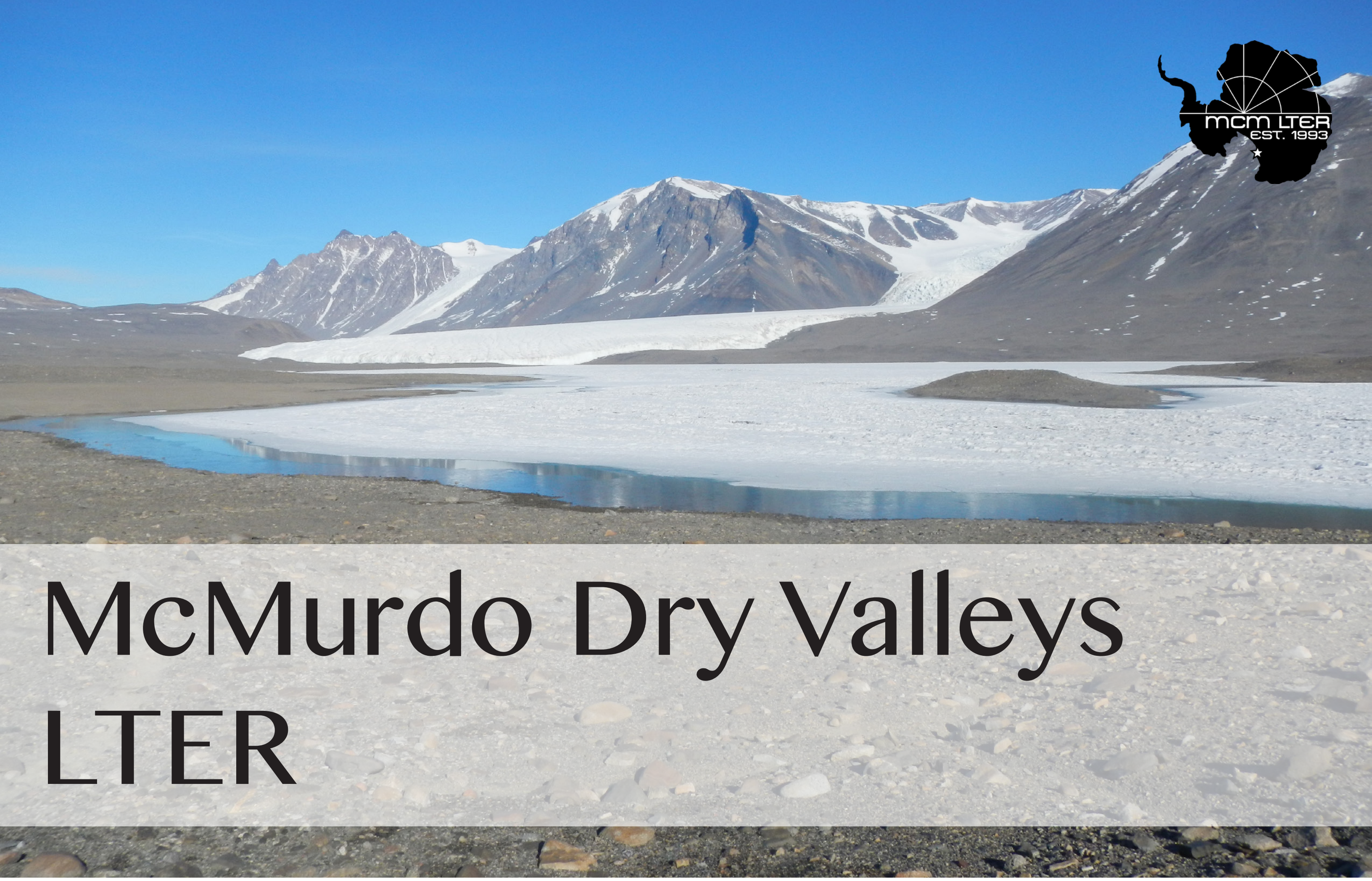


McMurdo Dry Valleys LTER

The polar desert landscape of the McMurdo Dry Valleys is a mosaic of inter-connected arid soils, glaciers, streams, and ice covered, closed basin lakes. With less than 10 cm water equivalent per year in precipitation, an annual mean temperature of -18°C, and no vascular plants, food webs are relatively simple. While microbial, algal, and invertebrate communities in the streams, soils, and glaciers are inactive during the austral winter, the ice covered lake communities are active year round.

The McMurdo Dry Valleys (MCM) LTER has explored the physical controls on ecosystem structure and function, the influence of past climate legacies (e.g., glaciation and lake inundation/recession) on the ecosystem, the interactions of climate legacies with contemporary biotic and physical processes, responses to climate warming in the region and associated increases in ecosystem connectivity. Current research is focused on how ecological resistance and resilience modulates the response of communities and ecosystems to amplified connectivity.

Between 2008-2018:

14 investigators

15 institutions represented

115 graduate students

Freshwater

Principal Investigator:

Michael Gooseff

University of Colorado, Boulder

Est. 1993

Funding Cycle:

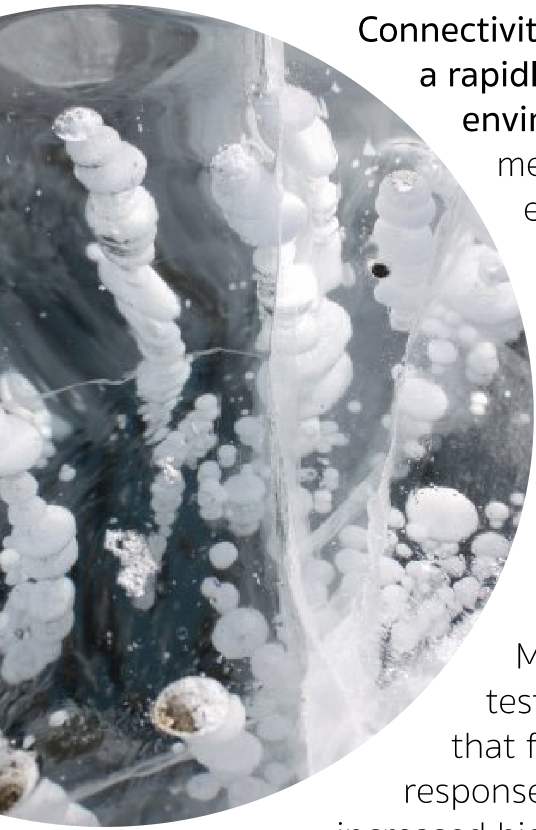
LTER V

NSF Program:

Geosciences / Office of Polar Programs

Key Findings

A single extreme summer has long lasting impacts on the McMurdo Dry Valleys ecosystem. During a decadal cooling period, productivity and hydrological connectivity synchronously decreased among terrestrial and aquatic ecosystems. As summer air temperatures and solar radiation stabilized in the following decade, the ecosystem moved back toward pre-cooling period conditions but in an asynchronous manner. This was due in part to the fact that the end of the cooling period was punctuated by the highest glacial melt summer on record. [Products 1-4]



Connectivity matters in a rapidly changing environment. Record melt and thaw events over the past decade have increased the physical connectivity of the McMurdo Dry Valleys ecosystem. Researchers at MCM LTER have tested hypotheses that focus on responses, such as increased biogeochemical cycling and changes in biodiversity. These studies suggest that landscape morphology is changing as permafrost thaws, and that biological communities are indeed responding to altered climatic conditions (e.g., high and low flow controls on stream benthic mat abundance). [5-7]

Significance of lake moats. In the austral summer, the shallow margins of ice-covered lakes melt, forming moats around the permanent ice covers of the lakes. Waters here interact with streams, soils, and the atmosphere (unlike those under the permanent ice). Recent study of these moats has uncovered these as the locations of the highest biomass per unit area in the dry valleys landscape.

Observed and experimentally induced changes in climate and hydrology are altering soil communities in the McMurdo Dry Valleys. Soil invertebrate communities in long term monitoring plots are responding to long term and seasonal changes in temperature and water availability, with key taxa exhibiting distinct responses. These changes are favoring rarer hydrophilic taxa, while the dominant species, an endemic free-living nematode which prefers cold dry soils, is declining in monitoring and experimentally manipulated plots. [1,8]

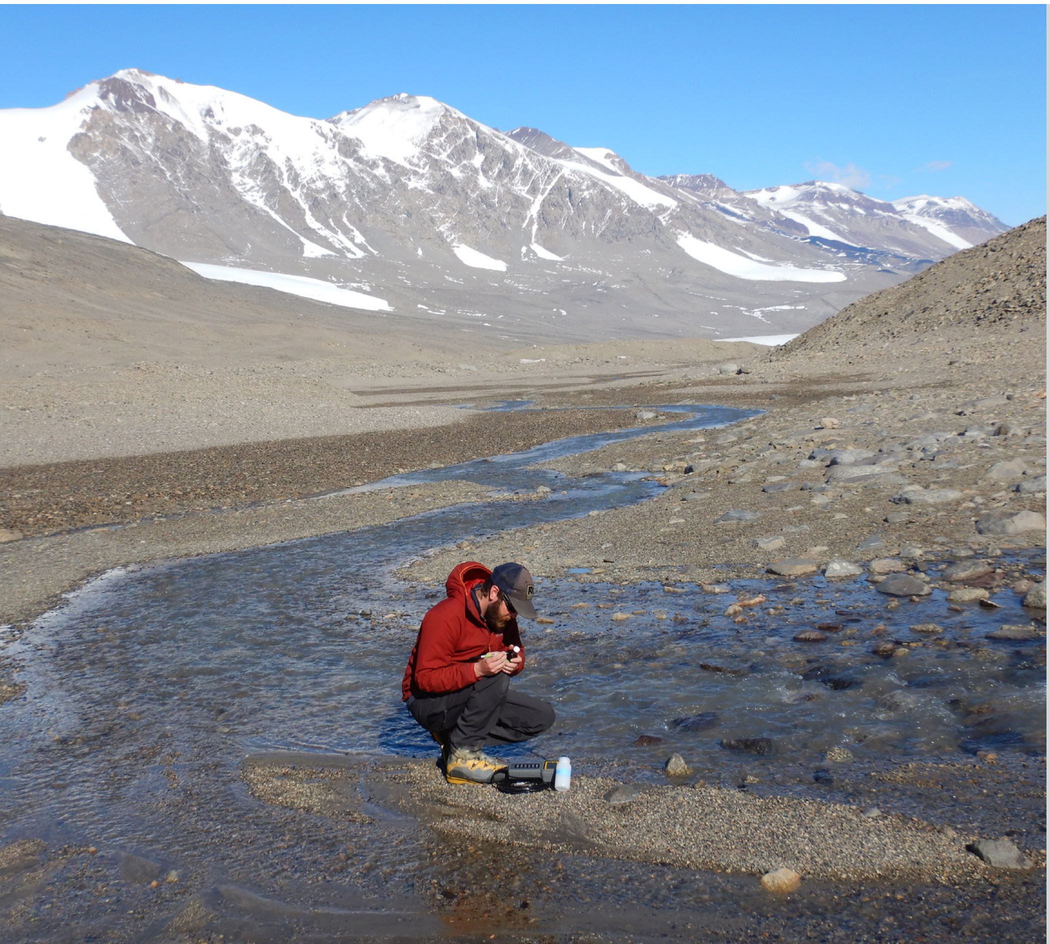
Photo credits: © Aslan Wright-Stow Hilke Giles, Antarctica NZ Pictorial Collection: K081C 08/09 (left); © Tracey Jones, Antarctica NZ Pictorial Collection: K024C 07/08 (top right); Amy Chiuchiolo / MCM LTER (bottom right)

Phytoplankton community diversity and function are sensitive to nutrients and light. Photosynthetic and mixotrophic eukaryotes are the dominant primary producers in the stratified water columns of the dry valleys lakes. Nutrient amendment experiments have shown that growth of chlorophytes, an obligate photosynthetic phytoplankton group, are stimulated by the addition of nitrogen or phosphorus in Lake Fryxell and nitrogen in Lake Bonney. Conversely, when communities are transplanted to the high light environment of open water moats, chlorophyte abundance and photosynthetic activity declined significantly. These results indicate that climate-related changes have conflicting impacts on phytoplankton communities (increased nutrient input versus lake level rise/expanding moats). [9,10]

Synthesis

Metacommunity Synthesis. The MCM LTER has been an intellectual leader in collaborative efforts to understand the impacts of metacommunity theory and extend its applications to understanding diversity patterns in a changing world. The resulting Metacommunities Synthesis Group, funded through the LTER Network Office, has produced a series of high profile papers and strengthened connections between NEON and the LTER Network.

Resilience on the Southern Continent. In 2016, MCM LTER published a special set of 3 papers in BioScience that compared the basic ecology of the two Antarctic LTER sites and the alignment of their responses to an anomalous summer. These collaborative papers demonstrated that across terrestrial and marine ecosystems, Antarctic communities are synchronously responding to the changes observed to date.



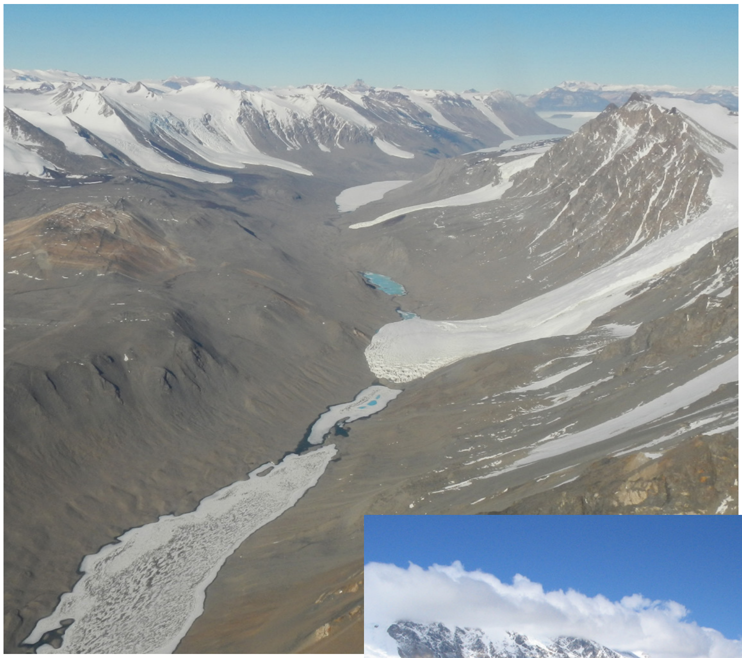
Data Accessibility

The MCM LTER database includes data from investigators at MCM LTER, collected as early as 1987, from all related field studies and laboratory analyses. These data are hosted in the MCM online database and through the Environmental Data Initiative (EDI) repository. The philosophy that data and metadata must be quickly and freely made available is instilled in students and postdocs throughout their time at MCM LTER.

Photo credit: MCM LTER

Broader Impacts

Bringing an extraordinary experience home. Access to Antarctica is limited, even for the MCM science team. Therefore, researchers have developed ways of engaging with this remote site through multimedia and personal storytelling to convey lessons learned to students around the world. Outreach is facilitated by the ability to conduct web conferences from Antarctica, news and popular media-initiated products, and through public, in-person presentations after researchers return from Antarctica.



The Lost Seal. The children's book *The Lost Seal* was the first to be published in the LTER Schoolyard book series. The book provided lessons about scientific field work and initiated a wave of new products from other LTER sites across the Network. With leveraged funding, the book has been translated into several languages and distributed around the world.

Human Connections to the 7th Continent. Despite Antarctica having no indigenous human population, the rich history of exploration and scientific endeavor provides a wealth of context for this ecosystem as it is understood today. With a particular focus on the theme of disturbance, environmental history research efforts focus on the human connections to the dry valleys from their discovery in the early 1900s to the modern era of drones and satellites as scientific tools.

Photo credits: MCM LTER (above and cover)

Top Products

1. Gooseff, MN et al. 2017. Decadal ecosystem response to an anomalous melt season in a polar desert in Antarctica. **Nature Ecology & Evolution.** doi:10.1038/s41559-017-0253-0
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3. Šabacká, et al. 2012. Aeolian flux of biotic and abiotic material in Taylor Valley, Antarctica. **Geomorph.** doi: 10.1016/j.geomorph.2011.12.009
4. Michaud, et al. 2012. Cyanobacterial diversity across landscape units in a polar desert: Taylor Valley, Antarctica. **FEMS Microbio. Ecol.** doi: 10.1111/j.1574-6941.2012.01297.x
5. Stanish LF et al. 2012. Extreme streams: flow intermittency as a control on diatom communities in meltwater streams in the McMurdo Dry Valleys, Antarctica. **Canadian J. Fisheries Aquatic Sci.** doi: 10.1139/F2012-022
6. Fountain, et al. 2014. The McMurdo Dry Valleys: A landscape on the threshold of change. **Geomorph.** doi: 10.1016/j.geomorph.2014.03.044
7. Okie, et al. 2015. Niche and metabolic principles explain patterns of diversity and distribution: theory and a case study with soil bacterial communities. **Proc. Royal Soc.-B.** doi: 10.1098/rspb.2014.2630
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10. Li et al. 2019. Influence of environmental drivers and potential interactions on the distribution of microbial communities from three permanently stratified Antarctic lakes. **Front Microbiol.** doi: 10.3389/fmicb.2019.01067.