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Inferring Surface and Subsurface Lake-Channel Connectivity in Arctic Deltas

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Arctic deltas (ADs) are ecogeomorphologically complex systems that are at risk due to climate and human forcings, e.g. warming temperatures and permafrost thaw. This will have impacts on natural and human systems since ADs have stores of permafrost carbon on the order of 90 Pg carbon, which can be mobilized into the atmosphere and ocean. Arctic lakes are estimated to be the source of two-thirds of the natural methane emissions in the Arctic and increasing methane emissions are predicted due to permafrost thaw. The role of water, sediment, and nutrient transfer between the delta channel network (DCN) and lakes in modulating greenhouse gas emissions is not well understood and further study is needed. Specifically, the identification and quantification of the spatially explicit distribution of lake-channel connectivity via surface and subsurface pathways is crucial for understanding residence and transport times of water and nutrients across the delta top. Here, we investigate the role of the DCN in controlling lake shrinkage rates on the delta top. A spatially explicit study of remote sensing data over two ADs reveals not only the importance of structural DCN-lake connectivity on lake shrinkage rates, but the control of the DCN on subsurface connectivity between channels and lakes. The importance of resolution in capturing processes on the delta top is highlighted. Remote sensing data available at delta-wide scales over significant temporal lengths for analysis of patterns and their change is at spatial resolutions that may not fully capture structural connectivity let alone potential subsurface connectivity between the channel network and lakes. An important problem then becomes that of understanding, via multiresolution analysis and modelling, how coarse scale structure and patterns might relate to finer scale patterns such that useful inferences on process and form can be made from widely available remote sensing data over large regions.