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Modeling Seasonality of River Discharge in Pan-Arctic Watersheds with Ring Width and Tracheid Anatomical Parameters

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November 23, 2022

Abstract

Polar regions are highly sensitive to climate change. In recent decades, the Arctic has warmed twice as fast as the world average, which has led to a significant loss of ice cover in the Arctic Ocean. The positive feedback from continental hydrology to Arctic warming amplifies perturbations in the climate system in response to changes in heat and freshwater fluxes. As the surface warms and storm paths change, precipitation and glacier melt have increased pan-Arctic runoff. Melting permafrost adds even more water to river systems. Our research aims to understand 1) whether this feedback impacts the river flow only in the warm season, 2) whether the runoff change in the cold (winter) season can amplify the initial warming, and 3) what is the spatiotemporal pattern of seasonal variations in streamflow across pan-Arctic watersheds. Tree rings serve as critical proxies for quantifying hydrological responses to climate change. We are exploring the potential of modeling seasonal flows, especially winter versus spring and summer flows, and water temperature using intra-seasonal aggregation of climate signals in subsets of ring chronologies derived from quantified tracheal cell parameters: cell area, tangential cell diameter, radial cell diameter, cell wall thickness. The preliminary results demonstrate significant correlation of summer water temperature with cell area and radial cell diameter, whereas the discharge correlates stronger with cell wall thickness and tangential cell diameter. We emphasize the importance of modeling intra-seasonal hydrological parameters versa the hydrological year average to analyze the contribution of continental hydrology to Arctic warming.

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FIHM 2022 Publishing Deadline: 17 June

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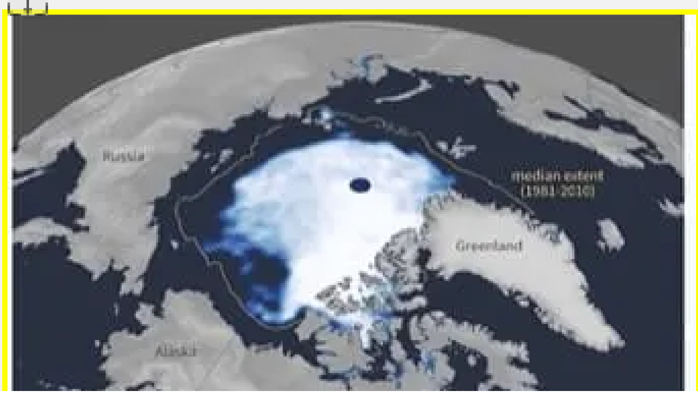
UPLOAD AUTHOR PHOTOS

Arctic Amplification



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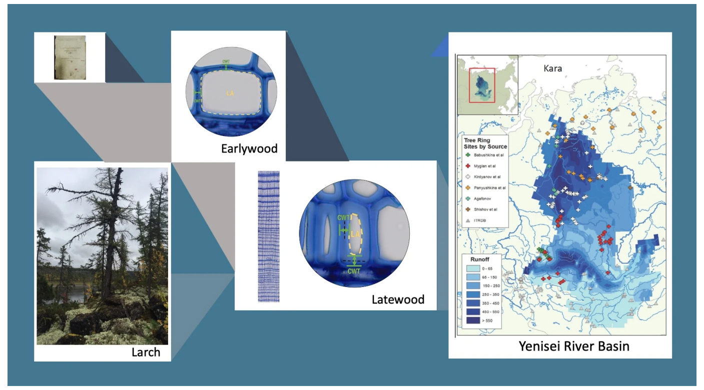
Tree Rings from Yenisei River Basin



The historical network of tree-ring width chronologies (Right map) is updated to 2019/2020 as well as the hydrological observations. A new type of tree-ring

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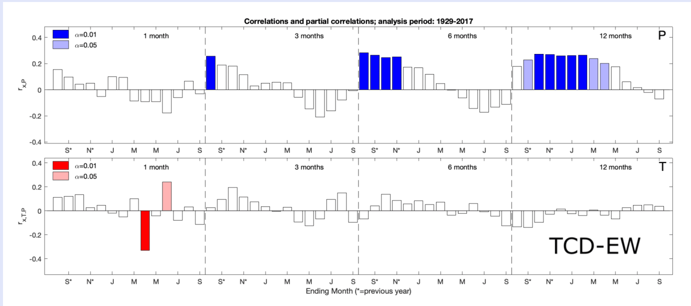
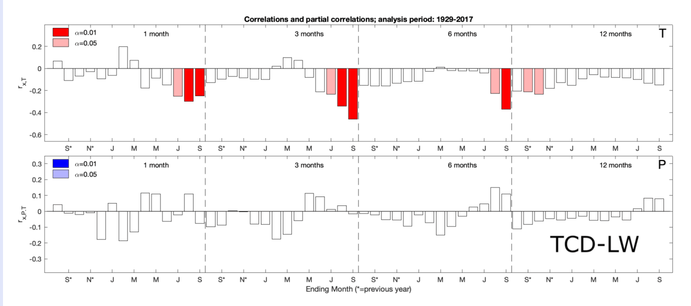
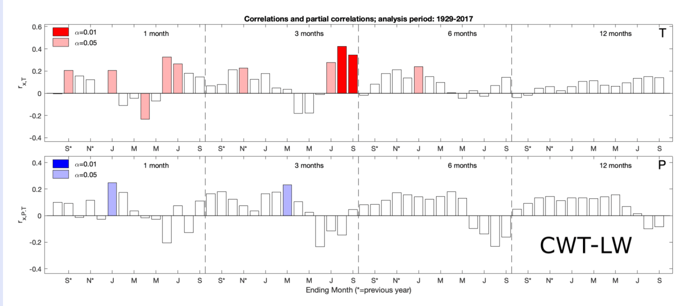
Climate Signal of Cell Dimensions



The intra-parameter pattern of climate response per ring. Correlation between air temperature (red), precipitation (blue), and cell dimensions. Climate data from the Turukhasnsk station, 1927-2017.





The climatic signal is recorded throughout the entire ring and each cell parameter has a specific zone

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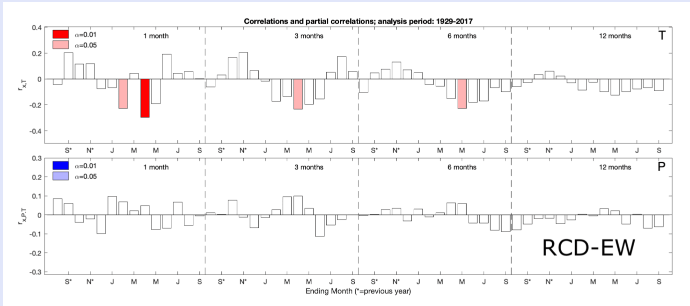
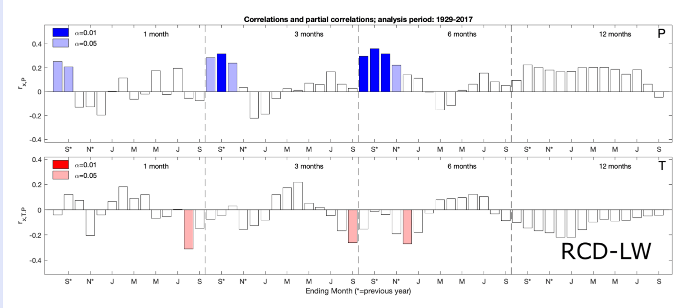
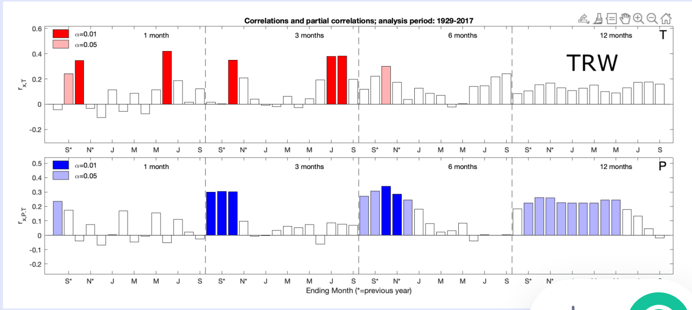
Climate Signal Segregation

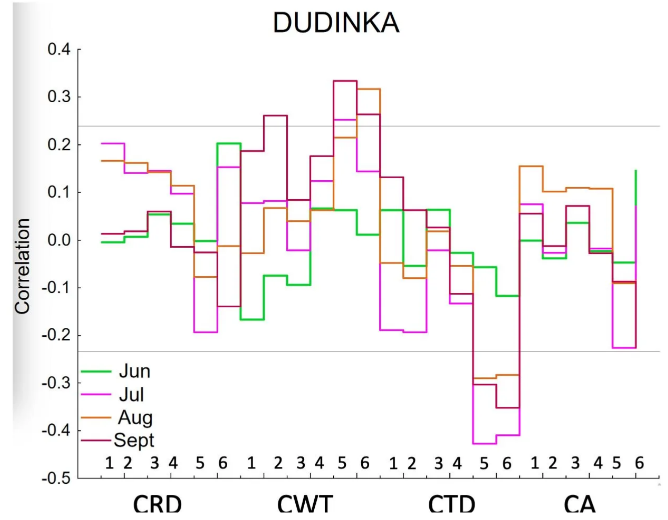




MIR site chronology from tree-ring widths (TRW) demonstrates the mixing Temp-Precip signal in the lower reaches of the Yenisei River.



Yenisei Water Temperature



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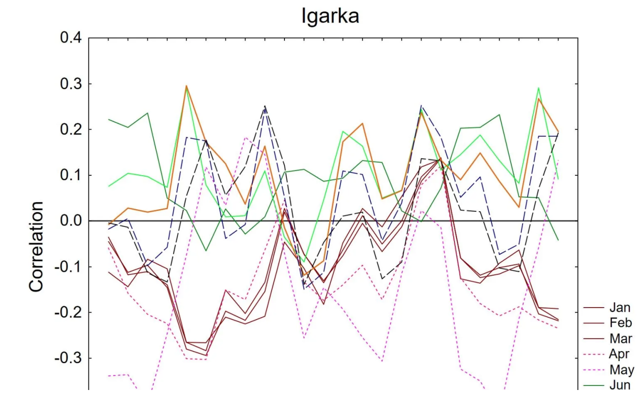
Response to the Yenisei Discharge



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