Climate Tipping Points: Enabling Decision-Making Tools for the Future Arctic Operating Environment

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Abstract

The Johns Hopkins University/Applied Physics Laboratory (JHU/APL) is developing machine learning, visualization, and modeling algorithms to enable climate-informed decision-making tools for the Arctic. These tools will help planners develop resilient future Arctic capabilities and infrastructure by allowing them to explore the evolving short-term and long-term Arctic environment. We touch here on two recent JHU/APL research efforts related to Arctic decision-making tools: one on forecasting short-term Arctic sea ice extent and another on climate-informed decision-making given potential longer-term Arctic changes, including permafrost thaw. We highlight the need to incorporate climate tipping points into future Arctic decision-making tools.

Tipping Points and Decision-Making for the Future Arctic Operating Environment

JHU/APL is developing machine learning, visualization, and modeling algorithms to enable climate-informed decision-making tools for the Arctic. These tools will help planners develop resilient future Arctic capabilities and infrastructure by allowing them to explore the evolving short-term and long-term Arctic environment. JHU/APL has done research in two recent studies: one on methods for short-term forecasting of Arctic sea ice extent and another on helping decision-makers understand potential longer-term changes in the Arctic, such as permafrost thaw. We highlight here the need to incorporate climate tipping points into future Arctic decision-making tools.

Significant efforts in developing climate forecasts for the Arctic on the decadal time-frame have been underway. Our research is incorporating the results of such models into tools that allow interactive exploration of potential future impacts of climate change. By geospatially aligning data and models, these tools can also provide datasets for AI-enabled predictive analytics, enabling new insights on the changing Arctic operating environment.

Understanding sea-ice extent, concentration, and anomalies, as well as their trends, can provide the much-needed recently demonstrated an AI-enabled approach to short-term sea ice extent forecasting.

It is already forecast that the Arctic will lose seasonal summer ice cover in the coming decades. However, recent modeling of Arctic sea ice remains uncertain as to whether or not there might be a complete tipping point in upcoming decades, where Arctic ice cover would not return for an entire year (Winton 2006; National Snow and Ice Data Center 2021; McKay et al. 2022). Reaching a tipping point of year-round ice-free Arctic event would have even broader economic and geopolitical implications.

JHU/APL has also developed a climate-informed future Arctic picture, to align projected permafrost thaw with other projected environmental changes to help infrastructure planners and residential communities adapt to their changing environment. This tool is adaptable, enabling regional to global focus, where data/visualizations can be tailored to the user. It is also modular, allowing new data to be easily integrated and visualized.

Scientists already estimate that 70% of existing Arctic infrastructure are in areas with a high risk of surface thaw by midcentury (Hjort et al. 2018). Cascading climate impacts and tipping points in permafrost thaw, could be even more devastating to Arctic communities and infrastructure (Fewster et al. 2022). Planners and decision-makers need improved tools to understand the likelihood and implications of permafrost tipping points.

Because of the significant implications on Arctic communities, infrastructure, capabilities, and geopolitics, Arctic tipping points need to be integrated into current Arctic adaptation and resiliency planning. Tipping point changes in sea ice and permafrost would dramatically affect navigability by sea, traversability by land, and have greater implications on the need for resilience of infrastructure across the Arctic. Decision-makers need new tools to understand the potential risks and implications of tipping point changes in the Arctic.

References

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