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Modeling and Extrapolating Arctic Feedback Loops using Macroeconometric Techniques

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The minimum extent of arctic sea ice (SIE) in 2019 ranked second-to-lowest in history and is trending downward. Hence, there is an immediate need for flexible statistical modeling approaches that both explain endogenously the trend of SIE and permits its extrapolation to generate a long-run forecast. To that end, we propose the VARCTIC, which is a Vector Autoregression (VAR) specifically designed to capture and extrapolate feedback loops that characterize the Arctic system. VARs are dynamic simultaneous systems of equations routinely estimated in economics to predict and understand the interactions of multiple macroeconomic time series. The VARCTIC is a compromise between fully structural/deterministic modeling and purely statistical approaches that usually offer little explanation of the underlying mechanism. Our "business as usual" completely unconditional forecast has September SIE hitting 0 around the middle of the century. By studying the impulse response functions of Bayesian VARs including different sets of variables, we single out CO2 shocks as main drivers of the long-run evolution of SIE. Additionally, we document that the corresponding responses of Sea Ice Albedo and Thickness largely amplify the long-run impact of CO2 on SIE. Finally, we conduct conditional forecasts analysis of remedies like reducing CO2 emissions or the implementation of Albedo-enhancing Geo-Engineering technologies.