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Formation of wind-driven ice bridges in narrow straits BHARGAV RALLABANDI, ZHONG ZHENG, Princeton University, MICHAEL WINTON, NOAA/Geophysical Fluid Dynamics Laboratory, HOWARD A. STONE, Princeton University — An ice bridge is a static arch made of tightly packed ice that can be formed when sea ice flows through a narrow strait between landmasses. The formation of a stable ice arch prevents the further flow of sea ice into warmer oceans, and therefore plays an important role in the regulation of the local climate and ecology and to an extent, the mass balance of Arctic ice. While ice bridges are a seasonal phenomenon in many parts of the Canadian Archipelago, the process of their formation and breakup is poorly understood. Using thin-layer theory along with dynamic sea ice models widely used in climate modeling, we develop a reduced-order description of wind-driven ice bridge formation in long, narrow straits. Our theory predicts a critical static condition for arrested flow that involves the ice properties (thickness and compactness), the geometry of the channel, and the magnitude of the wind stress. Further, we show that in a channel of varying shape and under a constant wind stress, a spatially uniform ice field evolves towards a steady state with discontinuities in its properties, consistent with observed mechanisms of ice bridge formation. The reduced-order model thus provides a predictive tool for the flow and stoppage of sea ice in straits.

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