



Instability time-scales of Antarctic outlet glaciers from similitude analysis

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Possible instabilities in Antarctica have the potential to eventually raise sea level by more than 20 meters. Recent observations and ice-dynamic modeling suggest that such an instability might have been triggered in West Antarctica. The corresponding outlet glaciers, Pine Island and Thwaites, showed significant retreat during at least the last two decades. While other regions in Antarctica have the topographic predisposition for the same kind of instability [U+2060] it is so far unclear how fast these instabilities would unfold if they were initiated. Combining observations with a similarity analysis of the ice-dynamic equation we show here that the similitude principle [U+2060] suggests that the Thwaites and Pine Island glaciers are likely to be the fastest in Antarctica. Applying scaling laws, as commonly used in hydrodynamics and engineering, to ice-sheet dynamics, the relative response times of different Antarctic ice streams after destabilization can be estimated from their observed relation of surface mass balance, basal friction and topographic geometry that result in their current force balance. Consistent with earlier studies^{3,4} [U+2060] the response time of Thwaites Glacier is found to be about twice as fast as that of Pine Island Glacier while the main outlet of East Antarctica's Wilkes Basin would be about twice as slow if destabilized. Although the present study suggests that there might be no faster instability in Antarctica than the ongoing destabilization in the Amundsen-Sea sector, it remains unclear whether amplified anthropogenic warming can overwrite the internal time scale of the ice streams and accelerate Antarctica's sea-level contribution beyond the instability.