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On the nature of iceberg calving: a self-organized critical state?

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Calving activity at the front of a tidewater glacier is characterized by long quiescent periods punctuated by sudden release of icebergs. Are those iceberg calving events predictable? What drives the calving process? To get more insight into the nature of iceberg calving we visually monitored the magnitude and frequency of icebergs at Kronebreen, Svalbard, during two summer periods in August 2008 and August 2009. In total, we collected 18 days of observations, which represented more than 7000 calving events, ranging from small ice blocks (1 m3) to entire ice walls (25 000 m3). Magnitudes have been assigned based on the size of the resulting icebergs. Both the magnitude and interevent times are well fitted by power-law relations. These power-law relations suggest that calving process is self-organized in a critical state. A self-organized critical state is a state that emerges spontaneously and that can respond to external perturbations on all time and length scales. This hypothesis is supported by further glaciological data. The fact that calving process is self-organized in a critical state implies that calving events are unpredictable but not random which means that the physics of iceberg calving is deterministic, but neither the time of the next event nor its magnitude can be predicted. Another consequence is that the same processes control both the small and the large events and that there might be no specific explanation for the largest events. In this view, the occurrence of a "catastrophic" event, i.e., the entire calving front collapsing, can be expected and characterizes a large response of the system. This last consequence is very relevant for the modeling of calving processes since efforts should be made to model all sizes and types of events if one wants to get a correct picture of what is happening at a calving front.