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Linear sea-level response of Antarctic tributaries to strong projected ocean warming underneath the Filchner-Ronne ice shelf

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Antarctica is the biggest potential contributor to future sea-level rise. Whether its ice discharge will become unstable and decouple from the anthropogenic forcing or increase linearly with the warming of the surrounding ocean is of fundamental importance for future projections. Under continued greenhouse-gas emissions, ocean models indicate the possibility of an abrupt intrusion of warm circumpolar deep water into the cavity below the Filchner-Ronne ice shelf within the next two centuries. The retrograde bed slope of the tributaries of this ice shelf suggests that an unstable ice-sheet retreat is possible in this region while the buttressing of the ice shelf and the narrow glacier troughs tend to inhibit such instability. So far, it is unclear whether the instability or the external forcing will dominate future ice losses for the highly buttressed tributaries. Here we show in regional and continental-scale ice-sheet simulations, which are capable of resolving unstable grounding line retreat, that the ice instability does not dominate the sea-level response of the Filchner-Ronne tributaries but that the discharge follows the strength of the forcing quasi-linearly. Exploring the ice-sheet response to melt-pulses from ocean projections with abrupt warm-water intrusion, we find that ice loss reduces after the end of each pulse and the long-term sea-level contribution is approximately proportional to the total shelf-ice melt. Although the local instabilities might dominate the ice loss for weak oceanic warming, we find that the upper limit of ice discharge from the region is determined by the forcing and not by the marine ice sheet instability. Generally, fast anthropogenic warming may override instabilities in inert cryospheric systems regarding their contribution to future sea level rise.