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Controls of the shelf break on warm water flow towards Antarctic ice shelves

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The potential collapse of the Antarctic Ice Sheet in a future, warmer climate and the consequent dramatic rise in sea level would cause flooding of large, densely populated areas. Observed accelerated thinning of ice shelves—linked to increased oceanic heat flux—threatens the stability of the ice sheet. The warm water that is found underneath ice shelves is located off the continental shelf in the deep Southern Ocean below a shallow, cold and fresh surface layer. To reach the ice shelf cavity the warm water has to pass two topographic barriers: the shelf break and the ice shelf front. Glacially carved troughs cross-cutting the continental shelf known to be important in channeling warm water southward.

We present results from a set of experiments conducted on a 13 m diameter rotating tank in Grenoble, France. The behavior of a slope current in a region where i) the continental shelf widens and ii) a trough opens up has been studied in an idealized setup. Barotropic and baroclinic currents were created by pumping water of different density along the continental slope and properties of the flow as well as the physical surrounding were varied systematically. Particle image velocitmetry (PIV) reveals that only a shallow, coastal current is affected by the widening continental shelf. A large portion of the along slope current—also water initially flowing over non-divergent, deeper isobaths—are diverted into the trough.