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Laboratory observations of increased plume entrainment in the presence of submarine canyons and ridges

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The continental slopes in the ocean are often intersected by small-scale topographic features such as submarine canyons and/or ridges. Cold, dense ocean currents that move geostrophically along the slope may encounter such features and portions or all of the dense water can then be steered by the topography down towards the deep sea. When the water is redirected in this manner it follows a shorter path to the deep sea, and it seems plausible that less total mixing will take place in the plume since the distance over which it entrains water can be much shorter. In order to investigate this question, a laboratory experiment has been conducted at the Coriolis rotating platform. A dense source was placed on top of a slope, and experiments were repeated with a straight slope, with a ridge, and with a canyon. The time development of the stratification in the receiving basin was monitored, and from this the total plume mixing could be calculated. Contrary to what was expected, the presence of a submarine canyon as well as a ridge increased the total mixing that took place in the plume. The product water that ended up in the laboratory basin was less dense when a canyon or a ridge was placed on the slope, compared to when they were removed. The reason for this extra mixing appears to be that the plume speeds up when it is steered by the topography, a phenomenon that has also been observed in the dense plume that moves along the Weddell Sea continental slope.