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Overflow through the Western Valley of the Iceland-Faroe Ridge is negligible

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The overflow of cold, dense water from the Norwegian Sea across the Iceland-Faroe Ridge (IFR) was discovered already in the late 19th century, but estimates of its volume transport are still fairly uncertain with the estimates approaching 1 Sv. The Western Valley (WV) is the northernmost passage crossing the ridge and has a sill depth slightly exceeding 400 m. Just upstream of this passage, the interface between dense overflow water and less dense upper waters is $\approx$300 m above this sill and simple hydraulic models would suggest a strong and persistent overflow through the WV (WV-overflow). Evidence for this has also been found in long-term current meter deployments at deeper levels downstream of the WV. This has motivated a general belief that there is a strong and persistent WV-overflow and that this is the main overflow path across the IFR. Here, we present results from a field experiment, lasting more than 9 months, with one bottom-mounted ADCP and two bottom temperature loggers deployed along a section crossing the WV close to the sill. From our observations, the bottom waters at the ADCP site are consistently cold indicating presence of overflow water, but typical velocities are surprisingly low and we find that the volume transport of WV-overflow is inversely related to the inflow of Atlantic waters going the opposite way in the upper layers. The average WV-overflow is estimated to be less than 0.1 Sv. Using a simple two-layer model, we identify three main reasons for the weak overflow: (1) a gently-sloping bottom reduces the cross-sectional area and hence the transport of the overflow layer. (2) Strong Atlantic inflow generates high vertical shear and deepening interface through the thermal wind equation. (3) Barotropic pressure gradients associated with sea-level differences between the sill area and upstream regions generated by the surface flow field reduce overflow velocities. Our results indicate that total IFR-overflow is considerably weaker than 1 Sv.