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Physical properties of methane-enriched plumes along the Hikurangi margin of New Zealand: Thoughts on sources and life spans of water column methane anomalies

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We explored methane distribution and physical mixing processes at active areas with CTD measurements utilizing a methane sensor combined with discrete water samples collected in Niskin bottles (24 bottle carrousel). Evidence of a methane plume injection was obtained during a CTD cast. The plume injection is thought to be the result of a vertical advective flow driven by a source of buoyancy (e.g., heat flux, bubbles, high dissolved methane concentration). Thorpe scale analyses on the high-resolution temperature data allow us to locate turbulent overturns and the associated small- to large-scale temperature inversions. Thorpe displacement analysis shows substantial overturns of ca. 30 m at around 720 m depth that perfectly correspond with a large peak (ca. 600 nM) of methane. This is likely the final intrusion depth of a methane plume originating from the sea floor. However, it is inconclusive which buoyancy source(s) are driving the plume (e.g. heat flux, bubbles, etc.). In the corresponding profiles, a completely well-mixed ca. 35 m thick layer (in T and Sal) is observed at this location. This further suggests a local buoyancy source. Substantial energy input is required to maintain such a well-mixed structure. In absence of a supporting energy source, this signal would be vertically diffusively smeared within several days ($t = z/Kz$), and much faster horizontally. Energy balances suggest that the source and

resulting upwelling are a dissolved methane-enriched thermal plume, as the number of bubbles required to produce such a plume and maintain the deep-mixed layer is too substantial.