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Two approaches to describe intrusions in the upper layer of the Deep Polar Water (Arctic Ocean)

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A comparative analysis of estimates of the formation time for intrusions observed under absolutely stable thermohaline stratification in the upper layer of the Deep Polar Water (DPW) is presented based on two different approaches: 1) 2D instability model of the baroclinic front accounting for differential mixing [1], 2) 3D instability model of the geostrophic flow with a linear vertical velocity shear accounting for diffusion of buoyancy and momentum [2]. The instability of the baroclinic front described by model 1 is a monotonic instability. The unstable modes are presented by periodic trigonometric functions; they have no along-front slope. According to model 2, the phase velocity of unstable disturbances depends on the along-front wavenumber k, and the instability is observed in a wide range of horizontal scales: there are unstable long-wave modes with a phase velocity exceeding the maximum value of flow velocity (see [3, 4] for detail), unstable modes on the scales of the Rossby radius, and short-wave perturbations with scales significantly smaller than the Rossby radius (submesoscale structures).
For weak geostrophic currents with velocity of about 1 cm/s, which is typical for the upper layer of the DPW, and for typical hydrological parameters of the observed fronts, the formation time of intrusions was found to be about several years for model 1 and about 50-100 days on the scales of the Rossby radius for model 2. A discussion on the description of DPW intrusions based on these two approaches is presented.
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