Geophysical Research Abstracts,
Vol. 10, EGU2008-A-01264, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-01264
EGU General Assembly 2008

1 Thermal bar considered as the result of horizontal convection

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Laboratory and numerical results are reported, demonstrating the development of the thermal bar in a basin with sloping bottom. It is shown that both spring and fall crossing over the temperature of maximum density are dynamically equivalent: a phase (i) of destabilyzing surface buoyancy flux and subsequent denser water cascading from the slope is replaced by a phase (ii) of stabilyzing surface buoyancy flux and subsurface jet formation. Near the temperature of maximum density, surface heat fluxes cause a very small buoyancy flux, thus, vertical motions are weak, and all the dynamics is driven by large-scale horizontal density gradients. This way, the "fast stage" of the thermal bar development corresponds to the propagation of the horizontal warm convective jet from the shallows, and its speed can be predicted using the relationship obtained by horizontal convection considerations, namely: $u^3 \sim (B \cdot d/\beta)$, where B is the surface buoyancy flux at shallows, β is the bottom slope there, and$d$ is the depth of the thermocline. Since the latter increases with time in natural conditions, so does the speed of the thermal bar, what explains a very-well documented experimental feature. The permeability of the thermal bar front is shown to be supported by a return (compensating) on-shore flow, which is formed within intermediate layers and is common for the both regions: it supplies water for both cascading (in deeper parts) and subsurface jet in shallows. Numerical modeling is used to investigate horizontal water exchange throughout the process of the thermal bar development: in the phase of the

cascading, while passing the front, and in the phase of the subsurface jet formation. We conclude, that the thermal bar in its “fast stage” manifests itself through the front (convergence zone) in the upper layers only, whilst an almost iso-pycnic interior is drawn in quasi-steady compensating motions, slowly adjusting itself to large-scale horizontal density gradients. In the presence of the thermal bar front, water exchange through any vertical section is composed from three parts: off-shore discharges of the (weakening with time) gravity current and the (growing with time) subsurface jet, and on-shore compensating return flow. The work is supported by grant of RFBR 07-05-00850, 06-05-64138 and INTAS 06-1000014-6508.