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[Volume 8, Issue 4 \(July 1978\)](#)

Journal of Physical Oceanography

Article: pp. 613–626 | [Abstract](#) | [PDF \(1.67M\)](#)

Turbulent Free Convection in Fresh and Salt Water: Some Characteristics Revealed by Visualization

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(Manuscript received June 1, 1977, in final form March 22, 1978)

DOI: 10.1175/1520-0485(1978)008<0613:TFCIFA>2.0.CO;2

ABSTRACT

Tracers were used to reveal the motions within the boundary layer on water in turbulent free convection. The technique of obtaining a thin sheet of light with an inexpensive laser and a cylindrical lens is suggested as a convenient tool for classroom demonstrations and research. Some facts about high Rayleigh number free convection, often not revealed by quantitative point sensors, which will be illustrated with the accompanying photographs are as follows: 1) the “whole” thermal boundary layer at the air-water interface participates in the convection through cyclic instabilities, 2) the form of the convection is predominantly vertical sheets originating from narrow lines in the interface (also observed with “schlieren” by Spangenberg and Rowland), 3) whether the boundary is rigid or free does not affect the appearance of these lines appreciably, 4) the lines move about in an unpredictable fashion and interact with each other, 5) entrainment away from the boundary very quickly broadens the convection elements and 6) presence of salt strongly affects the horizontal scales of the convection in evaporating water. The latter point is also demonstrated with horizontal wavenumber spectra, and compared to theory. Discussions of similarities between convective systems in atmosphere and ocean and these laboratory observations are included.

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