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A Neutral Density Variable for the World's Oceans

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ABSTRACT

The use of density surfaces in the analysis of oceanographic data and in models of the ocean circulation is widespread. The present best method of fitting these isopycnal surfaces to hydrographic data is based on a linked sequence of potential density surfaces referred to a discrete set of reference pressures. This method is both time consuming and cumbersome in its implementation. In this paper the authors introduce a new density variable, neutral density γ^n, which is a continuous analog of these discretely referenced potential density surfaces. The level surfaces of γ^n form neutral surfaces, which are the most appropriate surfaces within which an ocean model's calculations should be performed or analyzed. The authors have developed a computational algorithm for evaluating γ^n from a given hydrographic observation so that the formation of neutral density surfaces requires a simple call to a computational function. Neutral density is of necessity not only a function of the three state variables: salinity, temperature, and pressure, but also of longitude and latitude. The spatial dependence of γ^n is achieved by accurately labeling a global hydrographic dataset with neutral density. Arbitrary hydrographic data can then be labeled with reference to this global γ^n field. The global dataset is derived from the Levitus climatology of the world's oceans, with minor modifications made to ensure static stability and an adequate representation of the densest seawater. An initial field of γ^n is obtained by solving, using a combination of numerical techniques, a system of differential equations that describe the fundamental neutral surface property. This global field of γ^n values is further iterated in the characteristic coordinate system of the neutral surfaces to reduce any errors incurred during this solution procedure and to distribute the inherent path-dependent error associated with the definition of neutral surfaces over the entire globe. Comparisons are made between neutral surfaces calculated from γ^n and the present best isopycnal surfaces along independent sections of hydrographic data. The development of this neutral density variable increases the accuracy of the best-practice isopycnal surfaces currently in use but, more importantly, provides oceanographers with a much easier method of fitting such surfaces to hydrographic data.

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