Abstract View

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Do Box Inverse Models Work?

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ABSTRACT

The performance of a box inverse model is tested using output from a near-eddy-resolving numerical model. Conservation equations are written in isopycnal layers for three properties: mass, heat, and salt anomaly. If the equations are free of error and the vertical exchange of properties between layers is negligible or known, the reference level velocity structure is quite accurately reproduced despite the underdetermined nature of the problem. If the interlayer fluxes of properties are not negligible and they are ignored, the solution for the reference level velocities is poor. If the interlayer fluxes of properties are included as additional unknowns in the inversion, they can be accurately estimated provided the column weights are chosen appropriately. Column weights that minimize the ratio of largest to smallest singular value (the "condition number") result in the best solutions for interfacial fluxes, and generally also for lateral fluxes. This choice of column weights also makes the inversion insensitive to data error: Inversions containing typical errors can be solved at full rank, obviating the need to estimate the rank. The choice of number of layers, and whether these layers are isopycnals or geopotentials, does not affect the accuracy of the inversion provided that interlayer fluxes are included as unknowns in the inversion. A reasonable estimate of solution accuracy is available by using the statistical approach to inverse problems, although this method can be sensitive to the choice of prior statistics.

Box inverse models do work, provided that they include interfacial fluxes as unknowns and that these are weighted appropriately. Such a model can successfully determine interfacial fluxes and, in some cases, horizontal fluxes. However, the model will not generally reproduce the detailed structure of the reference level velocities.

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