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Compact finite difference scheme for simulation of the sea breeze over Bushehr area

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In many numerical simulations of fluid dynamics problems, especially those possess a wide range of length and time scales, low-order schemes are not adequate. The compact finite difference schemes, introduced as far back as the 1930s, have been found to give simple ways of reaching the objectives of high accuracy and low computational cost. Compared with the traditional explicit finite difference schemes of the same order, compact schemes have proved to be significantly more accurate with the added benefit of using smaller stencil sizes, which can be essential when treating non-periodic boundary conditions.

The objective of the present work is to apply the fourth-order compact scheme for the simulation of the sea breeze circulations over Bushehr area, located on the southwestern coast of Iran, on the Persian Gulf. The model consists of two layers, first a thin surface layer, characterized by constancy with height of the vertical eddy fluxes of heat and momentum, second an overlying transition layer. In the lower layer equations are solved analytically while in the upper layer numerical methods are used.

To validate the model some existing numerical results are used and for the validation of the results over Bushehr area the observations are employed. To investigate the accuracy and efficiency of the computations the results of the fourth-order compact scheme are compared in detail with the conventional explicit second-order centered method. The results show good agreement between the model predictions and observations and detailed structure of the circulation is revealed using this efficient numerical scheme.