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On Seasonally Varying Control of the Black Sea Exchange Through the Bosphorus

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The two-layer exchange through the Bosphorus is described by a simple model in which the flows are controlled by the narrow constriction in the interior part of the Strait and the sill at the Black Sea end. Long term (seasonal) free surface displacements and storage in the Black Sea basin are allowed in the model. The simple nonlinear dynamics of the sea-strait system described as such can have two stable and one unstable fixed points in phase space. Depending on the forcing and the initial conditions, the system can oscillate around either one or both of the stable solutions. The sea level in the Black Sea has two steady solutions, one corresponding to a higher sea level difference than the other and the seasonally varying transient response determines the steady state sea-level around which the system fluctuates.

The seasonally varying fresh water runoff and surface water budget is represented as the driving agents for the system. The available data indicate that the seasonal fresh water budget is significantly different from year to year, which has profound effects on the interannual variability of the exchanges. On the other hand, the inclusion of friction at the Strait can also lead to chaotic behaviour even when the forcing is periodic. Overall, the exchange is expected to be variable in the long term.

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