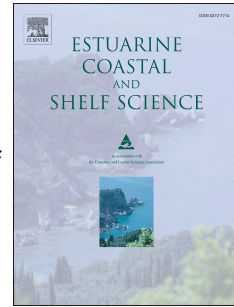


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Wind-driven residual circulation and related oxygen and nutrient dynamics in the Gulf of Finland (Baltic Sea) in winter

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1 **Wind-driven residual circulation and related oxygen and nutrient dynamics in the Gulf of**  
2 **Finland (Baltic Sea) in winter**

3

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12

13 **Abstract**

14

15 Establishment of distinct circulation patterns in the Gulf of Finland was observed by a targeted

16 measurement campaign in winter 2013-2014. Strong and long enough up-estuary wind events

17 caused a collapse of vertical stratification and development of a barotropic flow system

18 consisting of an outflow in the open part and inflow along the coasts. In the periods without such

19 unidirectional wind forcing, but when the water column remained weakly stratified, the residual

20 barotropic inflow in the open gulf and outflow along the coasts was observed. In the case of

21 moderate wind forcing, the three-layer vertical stratification and flow structure developed in the

22 gulf. It is shown that the along-gulf expansion of the fresher water tongue in the surface layer as

23 well as the up-estuary penetration of the saltwater wedge in the near-bottom layer followed well

24 the long-term (monthly) changes in the cumulative along-gulf wind stress. The dynamics of the

25 near-bottom saltwater wedge determined the extent of hypoxic bottoms and, as suggested by the

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