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Modeling water renewal times in semi-enclosed seas; application in Amvrakikos Gulf, Greece

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Water renewal of semi-enclosed coastal lagoons is vital for oxygen supply and the removal of pollution. There are various indicators of how fast the water is renewed via transport and mixing; the most common terms being used are the hydraulic retention time (HRT) and the residence time (RT). In the present work a computational determination of HRT and RT was performed for the Amvrakikos Gulf, a preserved ecosystem by national and international directives. The Amvrakikos Gulf is located in the north-western coast of Greece is one of the largest semi-enclosed embayments in the country being about 40 km long and 15 km wide. It is the largest wetland system in Greece consisting of the shallow marine waters of the Gulf, the deltas of Louros and Arachthos rivers and a lagoon system composed of 3 large and over 20 smaller lagoons. Water renewal of the Amvrakikos Gulf is of major importance since it is made exclusively via a narrow channel connecting the Gulf with the Ionian Sea that has a 3.0 km length, width ranging from 0.8 to 2.0 km and depth from 2.0 to 13.0 m. Computations were made using a 3-D integrated model that consists of the hydrodynamic sub-model FLOW-3DL and the water quality sub-model QUAL-3DL. FLOW-3DL; these models that have been developed in the NTUA involve the 3-D non-steady state continuity and momentum equations and the convection-diffusion equation for the concentration of a conservative pollutant expressed in layer formulation. A space-staggered computational grid was used that covered the area of the Amvrakikos Gulf and a small part of the Ionian Sea and consisted of 84x50 control volumes with constant resolution equal to 500 m and 7 layers in the direction of the depth. Calculations were performed for various environmental characteristics for tidal and wind hydrodynamic forcing, taking into account the input flow rates from the rivers Louros and Arachthos.