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# Water Renewal in Montevideo´s Bay II: a Compartmental Fractional Model for Tritium Kinetics

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This paper describes the construction of a new compartmental fractional model for water renewal in Montevideo's Bay that improves a conventional two compartments model [1]. The validity of the fractional kinetic model and its practical applicability are discussed. The available evidence suggests that the highly polluted Montevideo's bay operates as an intermittent tidal pump that injects contaminants in the nearby coastal waters, with potential effects on the beaches located east to the bay's mouth. In order to assess this effect, several field studies were done in the bay itself and in the adjacent coastal waters covering water and sediments dynamics [2]. In the framework of a field research of the dynamics and renewal of water in Montevideo´s Bay, 3.7 ×1012 Bq of tritiated water were evenly distributed in the north-east region of the bay, during five hours of continuous injection. The whole bay was divided in 20 concentration cells, taking into account available bathymetric data and corrections from field data obtained in situ. Tritium concentrations (activities per unit volume) and other relevant parameters (temperature, electrical conductivity, etc.) were measured in vertical profiles during three weeks, in the mid-point of each cell, first twice a day and the on a daily basis. Remnant total tritium activity was estimated from cells volumes and midpoint cells activity concentrations. The details of the measured tritium kinetics, available bathymetric data, water movements in a tidal environment measured with drogues, fluorescent tracers and current meters, as well as the results of computer fluid dynamics modelling (averaged in depth), suggests that in a first approximation the bay can be meaningfully divided in two main compartments: a North-East and a South-West compartment. The time course of the tail of the tritium remnant function suggests the use of fractional calculus to model the process of water renewal. The conventional two compartments model is generalized by the introduction of fractional derivatives (in Caputo´s sense) following a procedure that does not violate mass balance [3]. Fractional order parameters are estimated from available experimental data and the measured time evolution of the tracer remnant function is explained. The wash out kinetics from the bay of toxic chemical substances or dangerous microbial populations, introduced after a sudden contamination accident in the harbor, is described using the fractional compartment model and additional information from CFD simulations.

[1] Suárez Antola R (2013) Water renewal in Montevideo´s Bay I: A two compartments model for tritium kinetics, 2013 International Nuclear Atlantic Conference - INAC 2013, Recife, Brazil, ABEN DOI: 10.13140/2.1.2675.2005
[2] Suárez Antola R (2012) Tracer studies in the coastal waters of the Department of Montevideo, Proceedings of the Eight Meeting of the International Centre for Earth Sciences, Mar del Plata, Argentina DOI: 10.13140/2.1.3461.6322
[3] Dokoumetzidis A, Magin R and Macheras P (2010) A commentary on fractionalization of multi-compartmental models, J. Pharmacokinet. Pharmacodyn. 37:203-207.

## Country/Organization invited to participate

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