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Lumpy - an interactive Lumped Parameter Modeling code based on MS Access and MS Excel.

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Several tracers for dating groundwater (^{18}O/^{2}H, ^{3}H, CFCs, SF_6, ^{85}Kr) need lumped parameter modeling (LPM) to convert measured values into numbers with unit time. Other tracers (T/^{3}He, ^{39}Ar, ^{14}C, ^{81}Kr) allow the computation of apparent ages with a mathematical formula using radioactive decay without defining the age mixture that any groundwater sample represents. Also interpretation of the latter profits significantly from LPM tools that allow forward modeling of input time series to measurable output values assuming different age distributions and mixtures in the sample.

This talk presents a Lumped Parameter Modeling code, Lumpy, combining up to two LPMs in parallel. The code is standalone and freeware. It is based on MS Access and Access Basic (AB) and allows using any number of measurements for both input time series and output measurements, with any, not necessarily constant, time resolution. Several tracers, also comprising very different timescales like e.g. the combination of ^{18}O, CFCs and ^{14}C, can be modeled, displayed and fitted simultaneously. Lumpy allows for each of the two parallel models the choice of the following age distributions: Exponential Piston flow Model (EPM), Linear Piston flow Model (LPM), Dispersion Model (DM), Piston flow Model (PM) and Gamma Model (GM). Concerning input functions, Lumpy allows delaying (passage through the unsaturated zone) shifting by a constant value (converting ^{18}O data from a GNIP station to a different altitude), multiplying by a constant value (geochemical reduction of initial ^{14}C) and the definition of a constant input value prior to the input time series (pre-bomb tritium). Lumpy also allows underground tracer production (^{4}He or ^{39}Ar) and the computation of a daughter product (tritiugenic ^{3}He) as well as partial loss of the daughter product (partial re-equilibration of ^{3}He). These additional parameters and the input functions can be defined independently for the two sub-LPMs to represent two different recharge areas. For a user defined choice of up to five parameters (mean residence times and dispersion parameters of the two sub-LPM plus the mixing ratios of the two models) the best fit can be determined. Fits can be assessed using different methods for the Goodness Of Fit.

Input and output data are send to MS Excel for interactive display of modeling result and comparison with measurements. Excel only serves as data display; computations are performed in AB throughout. Lumpy allows display of time series and any combination of tracer vs. tracer plot. In the latter, the possible output data space assessable by the input variables can be displayed, to check if any of the model combinations under consideration is able to explain the measured data. Comparison and fit to measurements is possible after each of the two sub-models and after mixing these two. The talk will demonstrate the usefulness of this approach with examples from the Croatian Karst (Babinka 2007), the Fischa tracer test (Stolp et al., 2010) and the 30 years monthly tritium time series of the Danube (Aggarwal et al., 2010).

References:

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