Contribution ID: **419** Type: **Oral Presentation**

Modeling of the Darcy-Brinkman Equation Indicates Possibility of Deterministic Chaotic Behavior for Flow in Fractured-Porous Media

Wednesday, 1 June 2022 16:30 (15 minutes)

The goal of the presentation is to demonstrate examples of modeling of the Darcy-Brinkman (DB) equation, which can be used to describe nonlinear dynamical flow in fractured-porous media. The DB equation is presented as a surrogate system of four ordinary differential equations, including a kinetic component related to fluid velocity, pressure, and a gravitational potential. The results of modeling demonstrate the transition of the system from steady state to periodic and then to aperiodic, which exhibit oscillatory deterministic chaotic or random behavior. The results of simulations are illustrated using 2D and 3D phase-space (PSA) and pseudo-phase space attractors (PPSA). The PSAs are plotted from the time series of system variables. The PPSAs are calculated and plotted using the time lags determined from the mutual information function. Depending on input parameters, the attractors become either a closed loop or strange attractors. The state of the system is characterized using a set of nonlinear dynamics parameters–global and local embedding dimensions, a correlation dimension, an information dimension, and a spectrum of Lyapunov exponents. The system complexity is characterized based on calculations of the Kolmogorov-Sinai entropy. The Granger causality test is used to assess a null hypothesis of independence of time series variables. The results of simulations show high sensitivity to initial conditions and model parameters, which are typical for deterministic chaotic behavior. The solutions of the DB equation are important for developing hypotheses and directing experimental and modeling research to improve our understanding of subsurface flow and transport processes and interactions in fractured-porous media, relating to various environmental scientific and practical problems.

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References

Time Block Preference

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Participation

Online

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