Evaluation of Net Infiltration Uncertainty for Multiple Uncertain Input Parameters Using Latin Hypercube Sampling

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To assess, via numerical simulation, the effect of 12 uncertain input parameters (characterizing soil and rock properties and boundary [meteorological] conditions), on net infiltration uncertainty, the Latin Hypercube Sampling (LHS) technique (a modified Monte Carlo approach using a form of stratified sampling) was used. Each uncertain input parameter is presented using a probability distribution function, characterizing the epistemic uncertainty (which arises from the lack of knowledge about parameters—an uncertainty that can be reduced as new information becomes available). One hundred LHS realizations (using the code LHS V2.50 developed at Sandia National Laboratories) of the uncertain input parameters were used to simulate the net infiltration over the Yucca Mountain repository footprint. Simulations were carried out using the code INFIL VA_2.a1—a modified USGS code INFIL V2.0. The results of simulations were then used to determine the net infiltration probability distribution function. According to theoretical considerations, for 12 uncertain input parameters, from 15 to 36 realizations using the LHS technique should be sufficient to get meaningful results. In this presentation, we will show that the theoretical considerations may significantly underestimate the required number of realizations for the evaluation of the correlation between the net infiltration and uncertain input parameters. We will demonstrate that the calculated net infiltration rate (presented as a probability distribution function) oscillates as a function of simulation runs, and that the correlation between net infiltration rate and the uncertain input parameters depends on the number of simulation runs. For example, the correlation coefficient between the soil (or rock) permeability and net infiltration stabilizes only after 60–80 realizations. The results of the correlation analysis show that the correlation to net infiltration is highest for precipitation, bedrock permeability (positively correlated), soil depth, and potential evapotranspiration (negatively correlated). The net infiltration uncertainty analysis indicates the need to focus on more detailed investigations of these parameters to improve the aleatoric representation (which arises from the spatial and temporal variability of properties of heterogeneous subsurface media) of net infiltration processes, which have significant influence on percolation and transport processes through the unsaturated zone at Yucca Mountain.