A method for estimating dielectric permittivity variations in the shallow subsurface using tomographic radar first arrival times is presented. We expand upon our previous Minimum-relative-entropy (MRE)-Bayesian method by implementing a pilot point framework. We employ the principle of MRE as a means of non-subjectively choosing prior probability distribution functions (pdfs) for inversion targets, and utilize a Quasi-Monte Carlo sampling technique to draw samples from these prior pdfs. In our previous study, we treated dielectric parameters as zonal unknowns on a coarse grid, in order to reduce the dimensionality of the inverse problem. In this study, the targets of inversion are dielectric permittivity at chosen points selected from a fine-grid field and the parameters describing the correlation structure between these points. The number and locations of these points are selected in proportion to correlation length in order to avoid redundancy and capture areas likely to exhibit large contrasts in dielectric permittivity. For each numerical simulation, the dielectric and structural parameters are used to assign a dielectric permittivity value to each node on the grid through sequential Gaussian simulation. The output of the inversion includes parameter estimates in the form of pdfs that can be used as priors for further updating when more datasets are available. The MRE-Bayesian method can profit from time-lapse datasets, handle nonlinearities between data and model parameters, and quantify uncertainty. The integration of the pilot point method offers substantial improvement in the resolution of estimates and profits from knowledge regarding spatial correlation, such as known information about the lithology of the study area.